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AGRICULTURAL ECONOMICS RESEARCH

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Farm Mechanization Research in the South

By Grady B. Crowe

Economic research and some of the findings in regard to farm mechanization in the South are here summarized. Somewhat similar research now under way in the cotton fields of California is not included.

SOUTHERN FARMERS have seldom been lazy but they have experienced low per capita production and income compared with farmers in other major agricultural regions. The South has a long history of methods which use a great deal of labor in relation to other factors of production. Historically the major reasons for this intensive use of labor and for the lag in farm mechanization have been the large available supplies of unskilled labor and the fact that machines to meet the peak labor needs of the South's major cash crops had not been perfected. The magnitude of the lag in farm mechanization in the South is well illustrated by the fact that as late as 1945 the value of equipment per worker was less than one-half the national average. With considerably less investment in land, buildings, and machinery, the average southern farm worker was able to produce only three-fifths as much as the average farm worker throughout the Nation.

The fact that cotton, the most important farm enterprise on many farms in the South, requires five times as much labor as wheat and twice as much labor as corn to produce a given value of product illustrates the labor-intensive nature of cotton. In fact, man labor accounts for more than half of the cost of producing cotton. Because of the importance of the crop most of this discussion of farm mechanization research is centered around the cotton enterprise but the principal supplemental and companion crops are considered if they influence the mechanization processes.

Southern cotton farmers are faced with double-barrelled competition from synthetic fibers and foreign-grown cotton. The problem of altering to some extent the labor-intensive nature of cotton production is urgent if cotton producers are to meet price competition, without a further reduction of already relatively low returns to labor.

A rational appraisal of this problem brings with it the realization that this competition must be met both price-wise and quality-wise. One of the best-bet approaches to lowered production costs, and thus the chance to meet price competition, is the introduction of new methods and new machines in cotton production. Already the need for increased production efficiency in cotton, along with temporary labor scarcities caused by the war, has greatly accelerated the search for new techniques and labor-saving machines. Mechanical cotton pickers, mechanical strippers, flame cultivators, multiple-job tractor equipment, anhydrous ammonia as fertilizer, and chemicals for weed control, are examples of new machines and new techniques that have become realizations during the last decade.

As never before, cotton farmers are confronted

with the necessity to make almost immediate decisions as to whether they should mechanize their farming operations. Once the decision is made, a host of problems must be faced. How complete is the mechanization to be? Which of the new machines and new techniques fit best? Since most of the machines, the notable exceptions being harvesting equipment, are well adapted to the production of companion crops to cotton, these decisions obviously cannot be made on the basis of the cotton enterprise alone. Rather, the full appraisal of the benefit of machines must be made within the framework of the complete farming system. This is the reason mechanization becomes so complex a problem and in its ultimate effort must be recognized as a social as well as an economic revolution.

The Need for Research

Unfortunately, many decisions at the farm level relative to the adoption of new techniques are being made on a costly trial and error basis. To prevent this lost motion, research should (1) provide cost and performance evaluations of these new production techniques and furnish farmers with guides for their use and (2) develop an appraisal of how these new techniques fit into existing and potential farming systems. The second is probably the more important of the services research should provide.

The long-run objective of technological research on Southern farms is to improve the competitive position of the farm commodities produced by pointing the way for the development of a more efficient agriculture—an agriculture in which returns to production factors approach the returns to similar factors in other farming areas or in other economic endeavors. This objective is not an end in itself. The first test of any farm adjustment is its effect on the net income of the farmer, but the ultimate ends of mechanization must be viewed in terms of their influence on the social and economic structure of the farm economy, of the area and later of the Nation. For example, such questions as labor displacement and population shifts, associated with technological progress, must be studied and answered within the framework of the national economy rather than at the local or regional level.

Framework of the Research Effort

Recognizing the needs set forth in the preceding paragraphs, the Bureau of Agricultural Economics in cooperation with State Experiment Stations, initiated a regional project dealing with the economics of cotton mechanization across the Cotton Belt. Cotton will receive major attention in this regional project, but the mechanization of other crops is an integral part of the study and it is planned that the final appraisal will cover the entire production system of the region.

Because of the complexity of the economic problem associated with mechanization, and the fact that new machines and improved methods are constantly entering the picture, the project is being conducted in two phases. Phase 1 deals with economic evaluations of new machines and new production practices on the basis of their individual merit. Phase 2 will evaluate their position in existing and potential farming systems by appraising the effect of new techniques on the organization, operation, and income of farms in the Cotton Belt.

To cover the full range of conditions existing in the Belt, studies were located at points where findings would be generally applicable to broad areas. Conditions in both North and South Carolina are generally representative of those in the Southeast; conditions in Mississippi represent those of the Middle-south and the alluvial areas; Texas is representative of the Southwestern part of the Belt. Work is under way in these States to appraise the tractor as a source of farm power, to evaluate defoliation and mechanical picking and stripping as harvesting methods, and to measure other significant components of the mechanized process.

In some of these areas, as in the Mississippi Delta and the Texas High Plains, where conditions are rather favorable to mechanical farming, progress toward mechanization is taking place at a rapid rate. In such areas, the research is naturally somewhat more intensified.

Results from the studies being conducted in these sample areas will provide the basis for a regional summary and appraisal of mechanization and its implications on southern cotton farms.

This work is made possible in part by support from funds appropriated under the Research and Marketing Act of 1946.

Economic Appraisals of New Techniques

The All-Purpose Tractor.—Before the introduction of the all-purpose tractor during the late

1920's, the primary economic consideration on cotton farms was the most efficient use of mule power and man labor in relation to the acres of cotton which a family could chop, hoe, and pick. At that time, cotton was produced largely with mule power and either half-row or full-row equipment. Under these conditions, the labor requirements were high. The introduction of the tractor with its higher performance rates offered possibilities of greatly increasing efficiency in the production of this crop.

Recent studies conducted in the Delta show that the average annual operating cost for a medium (2-row) tractor is $518 and for a large (4-row) tractor $736 and the average annual cost, based on efficient feeding practices, for a single head of workstock is $142[1]. Since a medium tractor, in terms of performance rates, is equivalent to 6 mules, and a large tractor to at least 10 mules, it is readily seen that tractors are a more economical source of power.

The shift to tractor power also influences the costs of labor and machinery, making it necessary to take these two items into consideration. Table 1, which covers one cultivation operation on a large farm, is illustrative of the effect of tractor power on the costs of labor and equipment. Thus, on farms that are large enough to employ these power units at the levels of average use, it is clear that the mechanical power units are cheaper from the standpoint of costs.

The situation on small farms where tractors cannot be used at average levels presents a somewhat different problem. The Delta study[2] compares mules and tractors as a source of power on a 30- and a 60-acre crop unit in terms of costs of preharvest labor, power, and equipment. On farms of this size, tractor costs are adjusted to take into account the longer life resulting from less use. On 30-acre crop units, mules are a cheaper source of power if family labor is considered to have no alternative opportunities of employment and is not charged as a production cost. But if family labor is considered a cost of production, the tractor becomes the cheaper source of power. On 60-acre crop units, the tractor is cheaper regardless of how family labor is considered. This treatment is entirely in terms of cost. Other factors affecting mechanization on small farms are discussed later.

TABLE 1.—*Costs of power, labor, and equipment per day and per unit of work accomplished, one cultivation, large cotton farm, three levels of equipment, Yazoo-Mississippi Delta* [1]

Source of power, level of equipment, and items of cost	Cost per day	Work accomplished per day	Cost per acre	Percent of total costs
	Dollars	*Acres*	*Dollars*	*Acres*
One-row mule:				
2 mules	3.64		.52	50.0
Labor	3.00		.43	41.3
Equipment	.62		.09	8.7
Total	7.26	7.0	1.04	100.0
Two-row tractor:				
Medium tractor	6.87		.31	49.0
Labor	4.50		.20	32.0
Equipment	2.70		.12	19.0
Total	14.07	22.2	.63	100.0
Four-row tractor:				
Large tractor	7.04		.17	46.0
Labor	4.50		.11	30.0
Equipment	3.83		.09	24.0
Total	15.37	41.2	.37	100.0

[1] Based on average annual use of the various types of power and equipment and 1949 price relationships.

FLAME CULTIVATION AND CHEMICAL WEED CONTROL.—Weed and grass control is the sole remaining obstacle to the complete mechanization of cotton. Accordingly, the need for labor-saving methods in weed control, in order to bring balance to the over-all mechanization program, has resulted in the development of many machines designed for this purpose. Probably the most important of these to date is the flame cultivator. This machine is a tractor-mounted unit using as fuel one of the liquid petroleum gases, propane or butane. Killing action on weeds and grasses is obtained by directing a jet of intensively hot flame into the drill-row at the base of the cotton plants. Cultivation of row middles with sweeps is usually carried out simultaneously with flaming. The cotton plants must be 6 to 8 inches high and 3/16 of an inch in diameter at the ground level before the initial flaming operation takes place. At this stage the cotton plants are tough enough to withstand the flaming heat.

Flame cultivators studied in the Delta covered, during the season, an average of 110 acres of cotton 4.2 times, or an equivalent of 462 acres once

[1] Based on an average annual use of 75.3 days for medium tractors, 104.7 days for large tractors, and 78 days for mules and 1949 price relationships.

[2] See GAINES, JAMES P., and CROWE, GRADY B. WORKSTOCK VS. TRACTORS IN THE YAZOO-MISSISSIPPI DELTA. Miss. Agr. Expt. Sta. Bul. 470. March 1950.

over per machine. The average cost of operating a four-row flame cultivator, exclusive of labor and power, was $0.60 per acre per flaming, or $2.54 per acre for the season. When labor and power are included as costs, these figures are $0.96 and $4.04 respectively.[3] Unfortunately, the costs of flaming do not represent the entire seasonal outlay for weed control since some hand labor is usually necessary to control weeds and grasses during the period between planting and the time the cotton is large enough to be flamed. On the average, farms using flame cultivation and hand labor, compared with farms using hand labor alone, effected a savings of approximately $3 per acre on weed-control operations in 1947.

The fact that flame cultivation has not proved to be the full solution to the problem of grass and weed control in cotton has spurred researchers to increased efforts along other lines. One of the most promising approaches to the solution at present lies in the use of herbicidal oils as weed-killing sprays. These oils are sprayed into the row at the base of the cotton plants. They kill young weeds and grasses by a differential contact action. One of the most promising features of this method is that early applications of oil may be made immediately after the emergence of the cotton plants in the spring. It is too early to generalize from research findings to date, but a preliminary economic evaluation of this method of control, both alone and in conjunction with flame cultivation, is being made jointly by researchers in chemical weed control and economists, on field-size tests in Mississippi, during the current year.

Mechanical Harvesting.—Harvesting cotton by hand has long been a tedious and time-consuming operation, accounting, in high-yielding areas, for 65 percent or more of the total labor requirements. The recent development of practical machines for picking and stripping cotton has provided farmers with an opportunity to make great reductions in the labor requirements for this crop. These machines are often described as the greatest labor-saving devices in cotton production since Eli Whitney invented the cotton gin. Studies are under way across the Cotton Belt to ascertain the economic feasibility of harvesting cotton mechanically under different production situations.

In the Southwest and some of the Hill areas of the Belt, where the small stalk growth is conducive to the use of mechanical strippers, these machines are rapidly gaining favor. Results of a study in the Texas High Plains indicate a high economic potential for the use of strippers. These machines cannot be used satisfactorily until the leaves have dropped from the plant. Perhaps the greatest single hinderance to rapid expansion of this harvesting method is the need for a practical and economical defoliant which will remove the leaves earlier than would be done by frost.

In the alluvial and irrigated areas, where stalk growth is rank and yields are high, the spindle-type mechanical picker seems better adapted. Preliminary studies of the operation of this machine have been made in North and South Carolina, Mississippi, and Texas.

A total of 26 machines was included in the Mississippi Delta study in 1947. These machines operated an average of 308 hours and harvested 109 bales per machine. Bales harvested per picker for the season ranged from a low of 27 where the machine was used entirely for scrapping, to a high of 180 where used throughout the picking season. Time expended by machine operator and helpers amounted to 5 hours per bale of machine-picked cotton, in 1947. This compares with a usual hand-picking labor requirement of from 90 to 100 hours per bale.

Generally, three categories of cost are associated with mechanical harvesting: (1) machine operating costs, (2) waste or cotton left in the field, and (3) loss-in-grade. Machine-operating cost in 1947, adjusted to 1948 prices for machines, was $18.23 per bale; this cost consisted chiefly of depreciation and interest, 52 percent; repairs 22 percent; and labor, 17 percent. These costs are based on the 109 bale-picking volume mentioned earlier; they would be somewhat lower if the machine were operated at its estimated seasonal picking capacity of 150 bales.

Some waste is incurred in harvesting cotton mechanically as compared with hand picking. Picker efficiency tests conducted on plantations in 1947 reveal that machines are about 92 percent as effi-

[3] There are good arguments for excluding the costs of labor and power since flaming is usually done in conjunction with sweep cultivation, an operation which would be performed regardless of whether flame was used. The addition of the flaming unit to the tractor adds little if any to the regular labor and power cost. The figures are shown here to cover those cases in which only the flaming is done.

cient as hand pickers from the standpoint of clean picking. Picker efficiency varies greatly with crop conditions, yield, period of the picking season, and machine adjustment. Efficiently operated machines, under good conditions, may be as high as 95 to 97 percent as effective as hand harvesting. The 92-percent picker efficiency found in 1947 reflects a field waste of 8 percent. Valued at 1947 prices, this amounts to $13 per bale and is charged against the machine as a cost, for cotton left in the field is an economic loss to the producer.

Loss-in-grade has probably been the most troublesome factor in machine harvesting of cotton. Early attempts to use the machine resulted in quality losses of from two to three grades—an almost prohibitive differential, when compared with hand-harvested cotton. But better cultural practices, defoliation, and the use of more and better cleaning and ginning equipment, have reduced this quality differential to approximately one grade. Results of the Mississippi study indicate that the quality differential between hand and machine-picked cotton was approximately one full grade in 1947 which meant a difference of $7.90 per bale. Further improvements in cultural practices, machine operation, and ginning facilities, offer a prospect of reducing this cost still further.

The total cost of harvesting cotton mechanically, then, amounted to $39.13 per bale in 1947, when capital charges were calculated on the basis of 1948 prices for machines. This is equivalent to a hand-picking rate of approximately $2.65 per hundredweight of seed cotton. According to these calculations, machine-operating costs account for less than half the total cost of machine harvesting. This means that opportunities for increasing picker efficiency and removing quality differentials between machine- and hand-picked cotton offer a broad field in which to make improvements pointed toward reducing costs.

The Pilot Field Approach

Preliminary economic appraisals of new machines and new techniques are valuable both as an indication of their individual merit and as a basis for fitting them into an orderly scheme of production. Regardless of the starting point, whether it is a chemistry laboratory or an alley machine shop, if a technological finding is to be used on the farm it must become part of the adopted farming system.

TABLE 2.—*Yield per acre, man and tractor hours required per acre and per bale produced under two production systems, Delta Experiment Station, 1947*

Field	System	Yield per acre (seed cotton)	Hours per acre		Man hours per bale
			Tractor	Man	
1	A	2,184	3.15	146.55	100.7
	B	1,934	3.82	21.43	16.6
2	A	2,835	3.67	216.43	114.5
	B	2,487	6.13	47.45	28.6
3	A	2,922	4.90	198.25	102.0
	B	2,601	6.43	23.68	13.7

The technique of a pilot field or proving ground offers a constructive approach to the problem of fitting new techniques into a farming system. In Mississippi, proving-ground tests of field size have been set up in cooperation with the agricultural engineers. They serve as a basis for approximating costs and performance of particular machines and practices when these are fitted into a production system. Plot findings and previous experience are used as a basis for the selection of particular operations to be included. Careful testing and analyses of combinations of machines and methods in pilot fields will provide guides for the development of low-cost farming systems, and will help to bridge the gap between plot findings and farm conditions.

In 1948, two production systems were tested. System A approximates the conventional method of cotton production with considerable hand chopping for weed control, and hand harvesting. System B was a high-speed, mechanized system, including flame cultivation and mechanical harvesting, with just enough hand labor to "get by." The systems were tested on three fields ranging from 5 to 15 acres, each being of a different soil type. Seed, fertilizer, and programs for insect control were the same for each system.

As shown in table 2, System B compared with System A reflects some significant reduction in man-labor requirements in all fields, ranging from one-fourth as much in field 2 to one-seventh as much in field 3. Per acre yields are higher under System A in all fields. Preliminary analysis of costs and returns indicate that, with 1948 cost-price relationships, both gross and net returns over direct expenses per acre were higher under System A than under System B. But the returns per hour

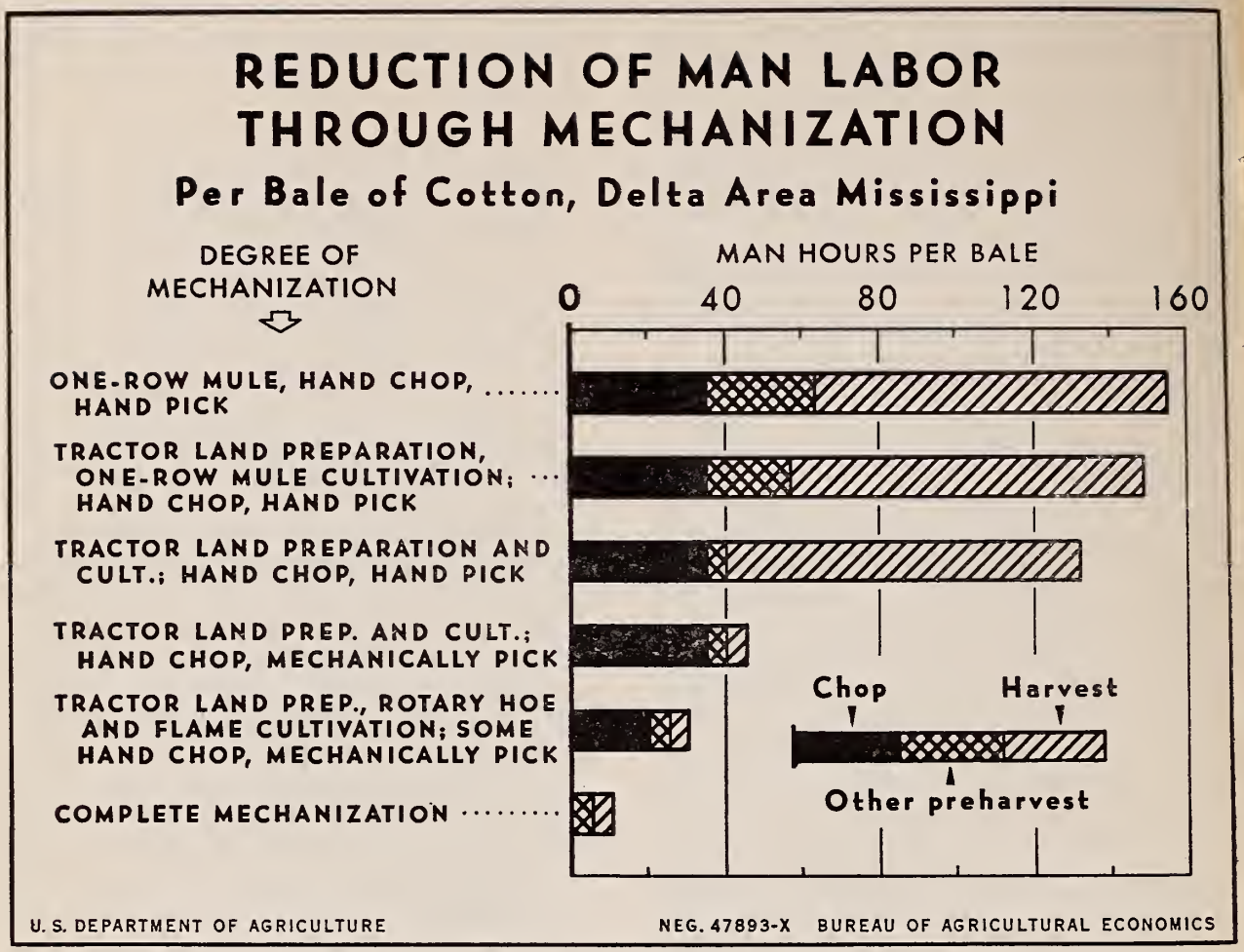

FIGURE 1.

of labor are much higher under System B. It may be that one of the important advantages in mechanization will lie in the possibility of shifting cotton production from a labor-intensive to a labor-extensive enterprise. It is probable that further modification of production system B could result in higher yields without materially affecting the level of inputs. In fact, attempts at such modifications are already under way in subsequent tests.

Mechanization and the Farms

In spite of the progress that has been made in mechanization, cotton is still produced with technology ranging from mule power and half-row equipment to tractor power and four-row machines, and with almost every conceivable combination of these and intermediate levels of equipment.

Mechanized practices have been adopted, on a few more advanced farms, about as far as tested experimental results would indicate as practicable. This has resulted in tremendous reductions in requirements for labor. Under a system of mule power and half-row equipment, 160 hours of man labor were necessary to produce an acre of cotton. By mechanizing as completely as possible with present equipment, only 20 to 35 hours of man labor are required, depending on the amount of hand labor that is necessary for the control of weeds. If and when the weed-control problem is solved, it is not inconceivable that cotton will be produced in some areas with as little as 10 hours of man labor per acre (fig. 1).

Scale of operation has a decided effect upon the rate of adoption of mechanized practices. Many machines used in cotton production are too large to be owned by small operators for use exclusively

on their own farms. This means that, for the present, mechanization of cotton will tend to be carried out on larger units. There is little doubt that mechanization will "pay" on large cotton farms

The opportunities for profitable mechanization that are apparent on large commercial farms become severely restricted as smaller farm acreages are considered. Cotton Belt farms of 30 acres of cropland or less—and there are a great many of these—are too small to be completely mechanized profitably. The use of machines on a custom basis has not proved to be a solution to this problem as yet. Ownership of tractors on small farms can be justified from a cost standpoint, but costs do not provide the complete answer. In general, neither the capital structure nor the credit facilities that are available to operators of small farms would allow them to make relatively large expenditures for machinery and equipment. A set of practical, difficult problems is involved in mechanizing of small farms. These problems form an especially fertile field for research. But it is not one to be approached along subject-matter lines. The solution will no doubt require the concerted and cooperated effort of engineers, economists, agronomists, entomologists, and other production specialists.

Mechanization and the Southern Farm Economy

As progress in the mechanization of agriculture in the Cotton South, thus far, is due largely to labor scarcities growing out of the conditions of World War II, no serious social effects have been felt as yet. If this substitution of capital equipment for labor—conditioned by the development of new skills and managerial capacity—is carried to the point of providing an efficient agriculture in the South, then a great many of the workers who are now on Southern farms would not be needed. These people cannot be considered as "economic extras." In order for the full social and economic benefits of mechanization to be realized, displaced human resources must be utilized in other segments of the economy, and as total society will be the ultimate benefactor, it would seem that that society should contribute to cushioning the shocks growing out of such progress.

For those people who remain in agriculture, with their increased skills and improved managerial ability, there is little doubt that greater production efficiency would enhance their opportunities for financial betterment. The size of the net product that will accrue to any given area will depend upon the proportion of the farms that are able to take advantage of new techniques and the speed with which such adjustments are made.

There can be little doubt that mechanization will affect the size of Southern farms. As it greatly increases labor's capacity for land, the old family-size cotton farm is likely to be too small for an efficient, economic unit. In addition to the increased need for capital to buy machinery and technical services, there will be a need for capital to buy additional land.

The South, with its vast stores of raw materials and undeveloped resources, is provided the opportunity, through mechanization and other technological advancements, to increase its productive capacity greatly, to provide new and higher levels of living for its people, and to overcome the disparity in income between it and other agricultural areas. It is the job of research to assist in pointing the way.

An Analysis of Certain Estimates of Food Requirements and Demand[1]

By Marguerite C. Burk

Current pressure of demand on our food supplies, resulting from the accelerated defense program, has renewed the general interest in the food needs of our civilian population. Concepts of food needs vary from minimum quantities of food required to maintain health and activity to full consumer demand. Several significant studies of food requirements and demand based on specified assumptions, made in the last 10 years, are summarized and compared in this article.

FROM TIME TO TIME, there has been occasion in recent years, to make estimates of food requirements for the civilian population of the United States and of consumer demand for food under certain assumed conditions. The purposes of such estimates and the methods used in making them have been varied: To indicate the magnitude of food requirements if all of our people were to have adequate diets; to provide Government agencies administering wartime food plans and controls with information on minimum food needs of the civilian population and on consumer demand for food; to indicate the potential demand for food and other agricultural products on an over-all basis under various assumptions as to economic conditions within the country; to show the areas of desirable adjustments within agriculture to meet food requirements or demand, or both, giving attention to the need for soil conservation.

Nine sets of estimates of food requirements or demand for food have been selected for study and these are given in table 1. They vary widely as indicated by the fact that the food-energy content ranges from about 3,050 calories per person per day to almost 3,900, and that the indexes of per capita food consumption which have been derived from the data range from 106 to 133 percent of the 1935-39 average. Accordingly, this article endeavors to review the assumptions, methods, and implications, of these estimates as a guide to their use as well as to bring out the reasons for the differences among them. Although other estimates of food requirements and demand were made frequently for administrative use during the war, they are not included in the following analysis because of the emergency character of their assumptions. Similar estimates made before 1942 have also been excluded.

All but two of the nine sets of estimates that are considered were published by the Department of Agriculture. Members of the staff of the Department assisted in preparing the other two. One of these was published by the Twentieth Century Fund; the other was utilized by the Council of Economic Advisers in the *Annual Economic Review,* 1950. The estimates can be classified readily into three types:

1. Estimates of quantities necessary to meet nutritionally adequate food plans of the Bureau of Human Nutrition and Home Economics.[2]

   (a) Moderate-cost diet and "best-adapted diet" estimates used in testimony of O. V. Wells before the Select Committee of the House of Representatives Investigating National Defense Migration, 1942. (Cols. a, b, and c, table 1.)

   (b) Estimates with the low-cost diet as minimum for the year 1942 published in USDA Tech. Bul. 963, *Efficient Uses of Food Resources in the United States* by Raymond P. Christensen. 1948. (Col. d)

[1] The research on which this article is based was made possible by funds provided by the Agricultural Research and Marketing Act of 1946.

[2] These food plans have been given by the Bureau of Human Nutrition and Home Economics in several publications, including PLANNING FOR GOOD NUTRITION by HAZEL K. STIEBELING and FAITH CLARK in Food and Life, 1939 Yearbook of Agriculture and Miscellaneous Publication No. 662 HELPING FAMILIES PLAN FOOD BUDGETS, December 1948. Weighted averages for the whole population for the low-cost and the moderate-cost plans are available in the mimeographed releases, PRICING OF DIET PLANS, BHNHE 354 Rev. (9/15/48) Forms 3A and 3B.

(c) Estimates with moderate-cost diet as minimum published in USDA Misc. Pub. 581, *High Level Food Consumption in United States* by W. W. Cochrane. 1945. (Col. e)

2. Demand for food under certain assumed conditions.

(a) Estimates of potential human consumption used by Assistant Secretary Charles F. Brannan in *USDA Testimony Proposing Long Range Agricultural Policy and Programs,* before Congressional Committees on Agriculture, April and October 1947. (Col. f)

(b) Demand for food, as well as other goods and services, in 1960 under prosperous conditions — Twentieth Century Fund, *America's Needs and Resources,* 1947. (Col. g)

(c) Estimates of demand in 1955-65 under conditions of full employment, given in *Long-Range Agricultural Policy, A Study of Selected Trends and Factors Relating to the Long-Range Prospect for American Agriculture,* prepared by the BAE at the request of the House of Representatives Committee on Agriculture. March 1948. (Col. h)

3. Demand for food under certain assumed conditions plus supplementary requirements to bring consumption of low-income families up to an adequate diet level.

(a) Estimates of demand in 1950, with full employment, plus supplementary requirements, published in USDA Misc. Pub. 562, *What Peace Can Mean to American Farmers,* 1945. (Cols. i and j)

(b) Estimates of demand with high income in 1954 plus supplementary requirements for low-income families, prepared for the Council of Economic Advisers, basic to statement on page 108 of *The Annual Economic Review,* 1950. (Cols. k and l)

Assumptions and Methods of Each Study

Moderate-Cost and Best-Adapted Diets.—The estimates of average food requirements under the moderate-cost diet, used by O. V. Wells in 1942, prepared in conjunction with the Bureau of Human Nutrition and Home Economics, utilized the distribution of population by age and sex, and by urban, rural and nonfarm, and rural farm location. The estimation of average requirements under the best-adapted diet necessitated a distribution of families by income group. This was based on certain assumptions as to national income, population, and price level for 1942. Implicit in the calculations were total national income of 90 billion dollars, a population of 133.9 million, and consumers' price index of 107 (1935-39 = 100).

Wells' best-adapted diet estimates really represented a composite estimate based upon the three diet plans of the BHNHE. That is, the low-cost diet plan was used for the nonfarm families with incomes under $1,000 and for the farm families with incomes under $750; the BHNHE moderate-cost plan for nonfarm families with incomes of $1,000 to $3,000 and for the farm families with incomes from $750 to $1,500; the BHNHE liberal-cost plan for nonfarm families with incomes over $3,000 and for farm families with incomes over $1,500. Consumption of nonfarm single individuals was carried at the moderate-cost plan, that of military personnel as an average of the moderate- and liberal-cost plans, and the low-cost plan was used for all others, such as institutional personnel.

A third set of estimates was made which allowed families with consumption rates above those in the best-adapted diet plan to continue their relatively high level of consumption. At the same time, all deficit diets were raised to the best-adapted level. Examination of family purchase data indicated that an overage of about 10 percent would be required for each food group.

Christensen's Estimates.—In his bulletin *Efficient Use of Food Resources of the United States,* Christensen calculated requirements for the year 1942 substituting the low-cost adequate diet as a minimum. Using the 1942 survey of food consumption (USDA Misc. Pub. 550) for average food consumption per person by income groups, for urban, rural nonfarm, and rural farm families, he raised those groups whose averages fell below the low-cost adequate-diet plan to the recommended quantities. No adjustment was made for averages which exceeded the quantities recommended in the low-cost plan. On page 12 of his bulletin Christensen shows only the percentage increase in over-all food consumption required to raise the population to these averages, by food groups. However, his basic work sheets have been used to derive the data in table 1 of this article.

In addition to requirements calculated in the above manner, he prepared some estimates of "pos-

TABLE 1.—*Comparison of several published estimates of requirements and demand for food per capita, by food group* [1]
(Retail weight equivalent)

Item	Unit	(a) O. V. Wells testimony, for 1942 [2]: Moderate cost diet	(b) O. V. Wells testimony, for 1942 [2]: Best-adapted diet	(c) O. V. Wells testimony, for 1942 [2]: Best-adapted diet plus allowance for higher consumption	(d) Christensen: low-cost diet as minimum for 1942	(e) Cochrane high-level food consumption in 1950	(f) Brannan: potential human consumption	(g) Twentieth Century Fund: demand in 1960, adjusted	(h) BAE long-range prospects: demand under high-employment 1955-65	(i) BAE, What Peace Can Mean: Estimated demand under full employment in 1950	(j) BAE, What Peace Can Mean: Supplemental requirements, average for whole population	(k) BAE estimates for Council of Economic Advisers: Demand under high income in 1954	(l) BAE estimates for Council of Economic Advisers: Supplemental requirements, average for whole population 2
Index of per capita food consumption, 1935-39=100		[3] 109	[3] 109	[3] 119	[3] 106	[3] 120	133	123	121	120	124 total	117	120 total
Dairy products													
Nonfat solids basis	Quarts	300	295	324	259	303	(306)	272	267	250	26	260	13
Fat solids basis, including butter	Pounds	[4]	[4]	[4]	[4]	[4]	1,014	[4]	875	885	56	820	38
Potatoes and sweetpotatoes	do	155	157	173	175	141	136	151	[5] 132	124	25	[6] 112	-----
Beans, peas, nuts	do	12	15	16	21	14	17	16	19	21	3	19	-----
Tomatoes and citrus	do	100	122	134	157	112	128	[7] 95	122	120	8	122	4
Leafy, green and yellow vegetables	do	166	160	176	125	157	102	115	124	114	1	124	6
Other vegetables and fruit	do	195	202	222	161	241	302	264	254	244	1	254	-----
Meats, poultry, fish [8]	do	131	127	140	128	155	192	190	171	173	-----	171	6
Eggs	do	[9] 37	[9] 39	[9] 43	[9] 34	[9] 39	41	39	44	42	-----	44	1
Fats and oils including butter and fat pork cuts	do	[9] 57	[9] 56	[9] 62	[9] 61	[9] 62	73	74	72	76	-----	68	-----
Flour and cereals	do	186	182	200	211	196	201	218	[10] 193	193	-----	[6] 170	-----
Sugar and sirups	do	[9] 57	[9] 59	[9] 65	[9] 53	[9] 93	132	118	117	122	-----	[6] 106	-----
Calories per person, per day [11]	Number	3,090	3,050	3,350	3,200	3,420	3,875	3,780	3,620	3,640	90	3,400	40

[1] See accompanying text for sources and description of assumptions and methods used.
[2] Prepared in conjunction with the Bureau of Human Nutrition and Home Economics.
[3] Estimated by author after making rough adjustments to put these data on basis comparable with other sets of estimates.
[4] Not available.
[5] Held at 1946 rate of consumption.
[6] Held at 1948 rate of consumption.
[7] Published figure was 106, but average from 1936 survey data exceeded 1936 per capita consumption.
[8] Excludes fat pork cuts.
[9] Excludes substantial quantities used in bakery products and heavy use in public eating places. In the case of sugar, excludes use in dairy products, canned goods, candy, and beverages.
[10] Held at 1947 rate of consumption, unrevised estimate.
[11] Estimated by the Bureau of Human Nutrition and Home Economics from data as shown in this table.

sible consumption changes'' which are the estimates of changes from the 1942-45 average that would raise all diets to an adequate level. These are essentially judgment estimates of quantities which would supply an adequate diet, not estimates of demand, but they do stay within a 10-percent increase in the cost of diet, and they were made to meet nutrient deficiencies. Because these are examples of how certain nutrition goals might be accomplished and are not calculated estimates of de-

mand or of requirements, the data were omitted from table 1 and are not discussed here in detail.

Cochrane's "High Level".—The estimates of "high level food consumption" developed by W. W. Cochrane in the publication by that name, involved much the same technique as that used by Christensen for his requirements. Cochrane assumed a total national income of 105 billion dollars with a consumers' price index of 105, food price index of 106, and a population of 144 million people—the projection at that time for 1950 under full employment. The "good adequate level" of food consumption which Cochrane worked out involved the use of the quantities recommended in the BHNHE's moderate-cost diet for those income groups in which the average rate of "actual" food consumption was less than 90 percent of rate considered to be adequate, except for potatoes and sweetpotatoes, where 80 percent of adequacy was the point of substitution. "Actual" food-consumption estimates were based on the consumption patterns by income groups in 1935-36, as derived from the consumer purchase data by Theodore Norman, Hildegarde Kneeland, and Selma Goldsmith, and as somewhat further developed by Cochrane. After considerable discussion of the income approach to higher food consumption, Cochrane recognized the fact that a supplemental food program might be necessary for low-income families as well as the fact that a major educational program for better nutrition would have to be carried on to persuade people to consume larger quantities of certain foods. But Cochrane did not consider the problem of over-consumption of some foods by the higher income groups which, in effect, he magnified by the addition of the supplemental requirements for other foods.

Potential Human Consumption. — The estimates of "potential human consumption" presented by Assistant Secretary Brannan in his testimony involved no estimates as to national income. The aggregates were derived by using a population of 142 million people (as of July 1946). The estimates were prepared by raising the consumption of all families with incomes below $2,000 to the average rates of consumption of families above $2,000, in 1941 (equal to $3,250 in 1950 prices). The estimates of "potential human consumption" are in effect estimates of what people would like to eat if they had sufficient income. Possible means of achieving these potential rates of food consumption were considered in other sections of the testimony given before the Agriculture Committee in connection with hearings on long-range agricultural policy.

Twentieth Century Fund Study.—The only set of data reviewed in this article which was not published under Government auspices is found in the book *America's Needs and Resources* published by the Twentieth Century Fund in 1947. These estimates were prepared from data supplied by Dorothy S. Brady (at that time with the Bureau of Labor Statistics) and Hazel K. Stiebeling (Bureau of Human Nutrition and Home Economics). They assumed for the year 1960 a total national income of 161 billion dollars, consumers' price index of 132 (1935-39 = 100), and a population of 155 million. The distribution of the population on and off farms by income level was derived from the distribution of farm and nonfarm family units by income levels multiplied by the average size of family for each income bracket. The per capita consumption of each major group of foods was developed from data on consumer purchases in 1936 and 1942 and adjusted to the 1940 price levels by interpolation. These averages by income group were multiplied by the population estimated to be in that income group in 1960.

Because the data were based on quantities purchased by families and did not include allowances for foods distributed through restaurants and other public eating places nor for use in some manufactured food products, the estimates as developed and published were not directly comparable with those made by the Bureau of Agricultural Economics. Therefore, they have been adjusted to a comparable basis by increasing the 1960 figure for each food group by the percentage difference between actual consumption in 1936, based on disappearance data of the Bureau of Agricultural Economics, and the 1936 survey data referred to in the table. The adjusted estimates are given in table 1. The estimates of demand in 1960, as developed for that publication, did not allow for any changes in price relationships or for trends in consumption. The publication of the Twentieth Century Fund also included a set of estimates of needs of the population derived by multiplying the age and sex distribution of the population by the quantities in the moderate-cost diet plan. These

estimates are so close to those used by O. V. Wells that they have not been reviewed for this study.

BAE Long-Range Prospects.—In the winter of 1947-48 the BAE prepared a special report, *Long-Range Agricultural Policy: A Study of Selected Trends and Factors Relating to the Long-Range Prospect for American Agriculture,* at the request of the House Committee on Agriculture. Included were estimates of what the demand for individual food commodities and major food groups might be under certain assumptions as to employment and economic activity. With high employment, disposable income might reach 200 billion dollars in the period 1955 to 1965 with a consumers' price index of 145 (1935-39 = 100) and a population of 158 million people. The average rates of consumption by individuals in different income groups, based on data in the 1936 and 1942 consumer purchase studies, were multiplied by the number of people who might be in those income groups under the projected level of population, national income, and employment. In order to allow for influences other than income, the averages of projected consumption for some food items, as indicated by the income distribution, were adjusted in accordance with historical trends in their consumption. This adjustment attempted to take into account such factors as gradual improvement in knowledge and practice of nutrition and shifts in the pattern of consumption as supplies change over time, and as the methods and channels of marketing of food commodities change. The estimates probably are still unsatisfactory from the standpoint of possible major changes in price relationships which may occur, and from the standpoint of possible major changes in the marketing of food commodities. Furthermore, as they are estimates of effective consumer demand, they do not allow even the minimum quantities of food necessary for good health for some low-income families who could not afford them or would not want to buy them.

Earlier BAE Estimates.—A set of estimates had been prepared by the BAE late in the war for its publication *What Peace Can Mean to American Farmers.* These estimates were worked out on the basis of a $150-billion total national income in the year 1950, a consumers' price index of 124 (1935-39 = 100), and an index of 130 for food prices, with a population of 144 million people.

These estimates were derived by means of three approaches. First, the total population was broken down into income groups and multiplied by estimates of consumption by individuals in the various income groups, derived from consumer purchase studies for 1935-36 and 1942. The average consumption for the entire population was then calculated. Estimates were also prepared on the basis of relationships of average income per person and average consumption of individual foods and of all foods combined. Third, long-time trends in consumption of individual foods were ascertained. The results of these three approaches were combined in arriving at the final estimates of demand.

Supplemental requirements were then considered. These requirements were to apply only to families with annual incomes of less than $1,500. The differences between the quantities recommended in the low-cost diet of the BHNHE (plus a 10-percent overage to allow for differences in distribution) and the estimated average per capita consumption of the lowest income groups were multiplied by the population in each group in 1950. No deduction was made for the consumption of items which might exceed the quantities recommended in the low-cost diet. Only the total quantities which might be necessary to supply such a supplement to the diets of low-income families were given in the publication, but these have been calculated on a national average basis for table 1 of this article. Supplemental requirements determined in this way involve only average consumption by income groups and do not allow for the fact that the consumption rate of a substantial number of people falls below the average. The publication noted that a supplemental food program might be necessary to handle these requirements.

Supporting Data for 1950 Economic Review.—The report to the President by the Council of Economic Advisers, January 1950, contains some projections of food consumption based on a set of estimates of demand in 1954 under the assumptions of a 238-billion dollar disposable income, 1948 prices, and a population of 156 million. These demand estimates, prepared by the BAE at the request of the Council, were derived in exactly the same way and in some instances they are identical with those used in the BAE data for 1955-65. Several adjustments were necessary from the estimates made in 1947-48 because of recent experiences with consumption of butter, fluid milk, potatoes, cereal

products, and sugar. The projected demand for butter and fluid milk was adjusted downward slightly. The estimates for potatoes (and sweetpotatoes) and for cereal products were held at the 1948 rates of consumption, which were substantially lower than the unrevised estimates of 1946 or 1947 average consumption which had been used for the report on long-range prospects. The projection for sugar and sirups was also held at the 1948 rate under the assumption that essentially the same price and supply relationships would be maintained.

Supplemental requirements to provide families with incomes below $2,000 with an adequate diet were worked out on a completely new basis by BHNHE and BAE. Information from the study of food purchases in 1948 by urban families was used to determine the percentage increase in the consumption of major foods which would be necessary to bring the consumption by all urban families who had incomes, in 1948, of less than $2,000 up to the quantities in the BHNHE low-cost diet plan.[3] The relationships between urban-rural rates of consumption found in a 1942 study, made by the Bureau of Human Nutrition and Home Economics and the Bureau of Labor Statistics[4] were used to estimate the percentage increase necessary to bring average consumption for the whole country to a level high enough to provide both urban and rural low-income families with quantities equal to the rates provided for in the low-cost adequate diet. These percentages were applied to the 1948 disappearance data per capita in terms of retail weight to get the average supplement per capita.

Comparison of the Estimates

The several sets of estimates of requirements and demand are difficult to compare in over-all terms because those based on food plans do not include sufficient allowance for eggs, sugar, and fats, used in restaurants and other public eating places and in commercially produced baked goods, dairy products, canned foods, candy, and beverages. This results from the fact that the food plans are prepared for family use in the homes. However, approximate adjustments were made in the Wells, Christensen, Cochrane, and Twentieth Century Fund data, by the author of this article and indexes of over-all per capita level of the estimates were computed in relation to the average U. S. per capita consumption in 1935-39 (using the same technique as that used for the per capita consumption index for The National Food Situation). These indicate (1) that the estimates by Wells were slightly higher than those by Christensen, (2) that the Wells "best adapted plus overage," the Cochrane, and the Twentieth Century Fund estimates, those that appear in "What Peace Can Mean," and the BAE long-range estimates are comparable in over-all terms, all assuming full-employment conditions; (3) that the latest estimates prepared by the BAE, for the Council of Economic Advisers, are slightly lower. The Brannan estimates are substantially higher because they are estimates of "potential human consumption," not of prospective effective demand. They come closer to what people really want to eat, not what they can afford to eat (as demand estimates do) nor what they need (as estimates based on the idea of adequacy do).

In view of the stress of most of the studies reviewed in this article on the importance of consumer income in the consumption of food, it is enlightening to examine the levels of income assumed by the studies. No income estimates were made for the Christensen and Brannan studies. Others have been put on a comparable basis by the author; that is, in terms of national income per capita in 1950 dollars. On that basis the income assumptions and the year in which they were made were as follows: Wells data, $1,075, 1941; Cochrane, $1,190, 1943-44; Twentieth Century Fund, $1,350, 1944; "What Peace Can Mean," $1,440, 1945; BAE long range prospects, $1,660, 1947; Council of Economic Advisers, $1,700, 1949. The years in which the estimates were made appear to have had considerable effect on the level of incomes assumed. This undoubtedly reflects the changing ideas over the last 10 years as to what income per capita could be with full employment and makes allowances for increasing productivity.

But it is apparent that the differences among the estimates stem primarily from basic assump-

[3] Based on unpublished data concerning frequency distributions of families by amounts of specified food groups used per person, from 1948 Food Consumption Survey by BHNHE.

[4] United States Bureau of Human Nutrition and Home Economics, family food consumption in the United States. U. S. Dept. Agr. Misc. Pub. 550, 157 pp. 1944.

tions as to certain fundamental questions. (1) Are the requirements to be estimated primarily on the basis of nutritional needs, adjusted as closely as possible to existing food habits (essentially the concept of the food plans of BHNHE), with or without provision of additional quantities to meet the full demand of higher income families at some assumed levels of national incomes? (2) Are food needs to include at least minimum adequate diets plus supplemental demand of higher income families but without adjustment for possible excessive food consumption? (3) Should food needs be interpreted to mean the quantities of various foods which Americans would like to buy if they could afford to do so? Another possible alternative is to determine requirements for food solely on the basis of physiological needs for nutrients, disregarding food habits and problems of distribution, but this is so unrealistic that it is rarely used.[5]

Only the Christensen study attempted to estimate how many people could be fed if the quality and quantity of food were lowered to a minimum nutritional level.

Further comparison of the estimates and their implications can best be made by grouping the estimates into the studies which made use of suggested food plans and those which were concerned with prospective or potential demand.

Some Implications

Studies Using Food Plans.—Estimates of food requirements, based on BHNHE's suggested food plans to supply adequate diets, are essentially suggestions as to what people "should" eat, not what they actually do eat. But the BHNHE does provide for the food preferences of families as much as possible within the limits set by food needs for adequate diet and by cost considerations. Many families who spend as much for their food as the total costs of the various food plans do not have adequate diets because of poor food habits, or lack of knowledge of good nutrition, or both.[6]

No attempt was made in these three studies to go into these problems: (1) How the incomes of many low-income families can be raised to permit higher expenditures for food; (2) how the families of all income levels are to be persuaded to change their food-buying patterns to provide adequate diets; (3) what compensating shifts in consumption of some foods might be desirable if the consumption of other foods is increased as recommended.

In view of the increase in domestic food production since 1942, the adjustments in production necessary to supply the requirements used by O. V. Wells appear feasible of achievement with the possible exception of the substantial increase in milk production. However, USDA Misc. Pub. 595 *Peacetime Adjustments in Farming: Possibilities under Prosperity Conditions* indicates the favorable prospects for this increase in milk production with higher yield per cow. The over-all changes in production to provide the necessary quantities of major foods in Christensen's estimates, based on the low-cost diet plan, appear to be feasible as do those for Cochrane's estimates based on the moderate-cost diet plan.

Differences in requirements for the major food groups in these three studies are due in large part to varying emphases of the food plans at three levels of cost, and to gradual revisions in those plans in the past decade. O. V. Wells' estimates of requirements based on the moderate-cost diet plan and on the combination of the diet plans at three cost levels, ("best-adapted"), reflect the larger quantities of milk and leafy, green, and yellow vegetables provided for in the diets of higher cost. The greater emphasis of the revised low-cost diet plans on tomatoes and citrus fruit and on inexpensive cereal products and potatoes, is indicated in higher requirements for these items in Christensen's data. The Cochrane estimates of "high level" food consumption combine the moderate-cost diet as a minimum with the above-minimum rates of consumption derived from 1935-36 consumer purchase data, thereby arriving at higher requirements (than in the other sets of estimates) for other vegetables and fruits (other than leafy, green, yellow vegetables, tomatoes, and citrus), and for meat, poultry, and fish.

Studies with "Demand Estimates".—Five of the sets of estimates in table 1 may be called estimates of demand. All were based to some extent on patterns of consumption by the several income groups, and all except the estimates presented by

[5] For discussion along this direction, see note by George J. Stigler. the cost of subsistence. Jour. Farm Econ. 27:303-314. May 1945.

[6] See United States Bureau of Human Nutrition and Home Economics, nutritive content of city diets. U. S. Dept. Agr., Special Report No. 2. October, 1950.

Assistant Secretary Brannan[7] utilized projections of total consumer purchasing power as well as the distributions of population by income group. Every one of these studies stressed the importance of full employment and high consumer incomes in estimating prospective demand for food. The estimates by the BAE for *Long-Range Agricultural Policy . . .*, *What Peace Can Mean . . .*, and for the Council of Economic Advisers also included some adjustments for long-time trends in consumption.

As noted above, the Brannan estimates of "potential human consumption" are materially higher for most foods than are any of the other estimates. Except for milk, even they could be supplied if necessary incentives for farmers were provided and reasonable time were allowed for shifts within agriculture. The adjustments in food output needed to supply the estimates of demand other than those in the Assistant Secretary's testimony are fairly comparable. But the latest BAE estimates would require smaller production of potatoes, cereal products, butter, and sugar, than would the other sets of demand estimates. These estimates take into consideration the postwar decline in rates of consumption. The major increase from present levels of output would be in livestock products.

Although the estimates of demand, other than those presented by Mr. Brannan, are not greatly different on an over-all basis, the estimates for certain food groups do vary considerably. The demand for potatoes and sweetpotatoes and for cereal products would be much higher, according to the data of the Twentieth Century Fund, than even in the earlier estimates of the BAE. No adjustments were made for long-time downward trends in these foods. Furthermore, the most recent estimates of BAE are even lower, for the reason indicated above. Estimates of future consumption of beans, peas, nuts, tomatoes and citrus, and eggs, based on Twentieth Century Fund information, indicate lower levels of consumption than do BAE estimates. The recent BAE estimate for eggs was adjusted slightly upward for the higher postwar rate of egg consumption, but there does not appear to be a ready explanation of differences for the other two food groups nor for the higher estimates for meats, poultry, and fish. The variations in the quantities of the fruits and vegetables other than those mentioned are relatively minor. The latest BAE approximation of what demand for sugar might be in 1954 involved holding per capita consumption at the 1948 rate, because of the lower rate of consumption in 1947-49, the legislation regarding sugar, and related controls.

Large increases in the production of fruit and dairy products, particularly fluid milk, compared with current output, would be necessary to meet the demand that might be expected under conditions of full employment in 1954, according to the latest estimates. Smaller increases in vegetables and meats would be necessary, and no increase would be likely for total domestic food consumption of potatoes and cereal products.

Estimates of Requirements to Supplement Demand.—It is now generally recognized that even under conditions of full employment and high consumer incomes, some families in the United States would still have incomes so low that they could not afford to buy the quantities of food recommended in the BHNHE low-cost diet, or who with their present food habits would not choose to buy the quantities necessary for an adequate diet.

In connection with two sets of estimates of demand for food—for *What Peace Can Mean* and for the Council of Economic Advisers—the BAE and BHNHE prepared some indications of supplemental requirements for food which would bring low-income families up to an adequate diet. Although the methods of estimating these requirements were quite different, as described above, the average rates of consumption, including the supplement, are similar. It is generally assumed that the distribution of these supplements to low-income families might be handled directly, or the families might be supplied with funds which would be earmarked in some way to show that they were to be spent only for food. As far as supplemental requirements are concerned, the most important commodity is milk. Special milk-distribution programs for school children have been operated successfully, for both fluid milk and dry skim milk, and the extension to other vulnerable groups of citizens would probably not be difficult from an administrative standpoint.

In Conclusion

Recent studies of food purchases of individual families have indicated again that there is a much

[7] Prepared by BAE under his direction.

greater chance that families with moderate or high incomes will achieve adequate diets than families with low incomes. At the same time, these studies have shown that many moderate and high-income families do not have nutritionally adequate diets. Therefore, it is apparent that a major educational effort as well as high levels of employment and income would be essential to the attainment by all families of even the minimum level of consumption used by these studies of food requirements.

Postwar experiences have demonstrated the dependence of agricultural well-being on the maintenance of a high level of domestic demand for food. The food-consumption rates of the last 3 or 4 years bear evidence that the demand for food is affected not only by the average level and distribution of real disposable income, but also by such factors as the alternative uses for consumers' purchasing power and the prices of food commodities relative to each other and to the prices of non-food goods and services. Accordingly, high levels of income do not in themselves assure the achievement of levels of demand for food indicated in the studies reviewed in this article.

Estimating Flood Damage to the Bean Crop in Michigan

By C. J. Borum[1]

Timelessness and accuracy are paramount considerations in making estimates of sudden local damage to crops. Here is an account ofone such appraisal and just how it was made.

WHEN A HURRICANE, flood, or freeze strikes a crop, the State Statistician and his staff must make a quick appraisal of the damage. A case in point occurred in Michigan during the latter half of July when heavy rains flooded much of the acreage of dry edible beans in Saginaw and Tuscola Counties where more than one-fourth of the State's crop is grown.

As often happens in such circumstances, unofficial reports of loss to the crop ranged from 5 to 50 percent. These reports reached the State Statistician's office only a few days before the end of July and the actual damage had to be assessed in time to permit the information to be used in the August crop report.

The story of how that was done is told here for several reasons. First, it is an excellent illustration of the kind of operation carried out by the State Statisticians that deserves some recognition. A job of that kind can be, and often is, carried out more objectively than many people realize. In the second place, the experience of the Michigan office should be useful to the Statisticians in other States when similar emergencies arise.

Someone from the Statistician's office must usually travel to the areas affected to get a picture of the situation at first hand. Sometimes this simply takes the form of a subjective appraisal based on a general inspection of the area and conversations with well-informed local people. Such a subjective approach sometimes gives misleading impressions, even to an experienced observer, and no one would deny that a more objective procedure would be highly desirable. The problem is to devise an objective procedure that can be applied quickly in a given emergency. There is usually not much time for preliminary planning and the field work must be done quickly if the findings are to be of real use. The flood situation described here is typical. But it was possible to get up a survey that did not require much more time than would have been taken by a subjective appraisal of the area on a field trip. Furthermore, after the survey was completed the estimates of damage and loss to the crop were estimates from which practically all personal judgment, with its possibilities of personal bias. had been eliminated.

Speed, as well as objectivity, was a primary consideration in planning the work. The entire survey had to be made in 2 days—August 1 and 2. A sample of 55 fields was all that could be covered in that time. Knowledge of the territory in-

[1] The study herein reported was made by E. H. Carter and H. F. Huddleston of the Michigan Cooperative Crop Reporting Service.

dicated that about 90 percent of all fields in the two counties were visible from roads that run north to south and east to west through the area, generally at 1-mile intervals. A systematic sample of six of the north and south roads traversing the two counties was selected. The selection was made by numbering all such roads, choosing one at random, and taking every k-th road thereafter.

The sample of 55 fields was allocated to the townships traversed in direct proportion to the estimated bean acreages in those townships (based on the 1949 acreage enumerated by P. M. A.). These were selected by first drawing a sample of 55 1-mile segments of route and then selecting one field from each such segment. To illustrate, assume that the estimated acreage in a township called for only one sample field and that there was a total of six 1-mile segments in the route for this township. A random number between 1 and 6 was used to select the sample segment. If the estimated acreage in the township called for two sample fields and there were six 1-mile segments in the route, a random number between 1 and 3 was used to select the first sample segment and 3 plus that number was used to select the second. One sample field was chosen at random from each sample segment, first numbering all fields in the segment and drawing a random number. The sample of 55 1-mile segments was drawn in the office before going to the field so that all the sampling that needed to be done in the field was to drive to each chosen segment, count the bean fields, and select one at random.

Any area of a sample field that contained no plants or only dead plants, dark brown or black in color, was classified as *lost*. Any area in which plants were clearly stunted, yellowing, or otherwise definitely retarded, was classified as *damaged*. The percentage of the total area lost, damaged, or both, was estimated separately for each field. In summary, the results indicated that 9.5 percent of the acreage in the two counties was lost and 4.8 percent was damaged, and that there was a decided decrease in the total acres lost and damaged from west to east. In addition, heavier loss and damage tended to be associated with the later developing fields, where the lateness may have been caused by late plantings or a combination of fairly late planting and poor drainage. A satisfactory estimate of the effect of the damage on yield could not be made at the time. It was recognized that the full effects of the flooding were not yet manifest—water was still standing in some of the fields. Obviously the future effects could not be ascertained accurately.

The same fields were visited again on August 24 and 25 when the situation could be more closely appraised. The lost acreage had by then increased to 10.9 percent and the damaged acreage to 5.8 percent. An attempt was made to measure the reduction in yield on the damaged acreage. Two plants from the damaged part of every field, and two from the undamaged part, were selected at random for examination. Where there were gradations in the damaged area, the sample plants were selected at random near the midpoint of the gradation between the worst-damaged and the undamaged area. Counts of pods per plant and beans per pod indicated that, on the average, the yield for damaged plants would be only about 20 ± 2.6 percent as large as for undamaged plants. Most of this reduction in yield was ascribable to a smaller number of pods per plant, although the number of beans per pod was also smaller.

There is no reason to believe that there would have been any difference in average yield between the flooded and unflooded fields, or parts of fields, if no flooding had occurred. The land is predominantly flat so that the flooded acreages were not unusual parts of fields, where one would have expected a different yield if there had been no flooding. Hence the yield differences found in the survey can safely be charged to the effects of flooding.

With about 11 percent of the acreage lost and 6 percent damaged, the indicated over-all yield for the two counties was thus $(.11)(0) + (.06)(20) + (.83)(100) = 84$ percent as large as it would have been if no flooding had occurred. Therefore the forecasts of yield for those counties, which had been made before the flooding, had to be reduced by 16 percent to take the effects of the flooding into account. A corresponding allowance had to be made in subsequent estimates of yield for these counties, with the reduction in yield for the flooded areas also properly reflected in the estimates for the State as a whole.

Averaging Farm Incomes for Income Tax Purposes

By Daniel W. Burch

Proposals that have been advanced or tried regarding methods of averaging farm incomes as a basis for the payment of income taxes are here considered and evaluated.

MANY OF THE IMPORTANT economic problems of farmers—especially in certain areas—are associated either directly or indirectly with unstable incomes. One of these problems concerns the equitable treatment of fluctuating incomes under the Federal individual income tax. Because of the progressive rate structure, a farmer who has a fluctuating income will pay a higher total tax than one who has a relatively stable income with consequent inequities between and among taxpayers. This paper is concerned with an evaluation of some of the more important suggested alternative methods of averaging incomes for tax purposes.

Under Present Law

The carry-back and forward of net operating losses of farmers and others who operate a trade or business is permitted by the present income tax law. Before the 1950 income year, losses could be carried back 2 years and any remaining amount of loss could be carried forward 2 years.

President Truman recommended in his recent message to Congress on the revision of the tax laws "that the loss carry-forward provision be extended from 2 to 5 years to provide more scope for offsetting losses of bad years against profits of subsequent years."[1] The Revenue Act of 1950 reduced the carry-back to 1 year but increased the carry-forward to 5 years. An operating loss on 1950 income would first be deducted from other current income, if any, with the remainder carried back to 1949 income. The farmer would have to apply for a refund of his 1949 taxes. If there still was an amount of loss not offset, the remainder would be carried over to 1951 income and, if necessary, up to 1955. Thus, it is possible that an operating loss may be spread over 7 years.[2]

The effect of carry-back and forward of operating losses is to reduce the income of the preceding year and subsequent years up to five. Losses from farming operations, which may be caused by low prices or low yields, are not likely to be distributed as to either amount or time in such a way that the total tax liabilities will correspond to those of a farmer who has a comparable stable income. Furthermore, many farmers who have fluctuating positive incomes would still be inequitably treated in comparison with farmers who have stable incomes. The offsetting of operating losses, although important, does not give adequate relief to all taxpayers who have fluctuating incomes. Hence, the remainder of this paper is concerned with an analysis of alternate income-tax averaging proposals for averaging incomes for tax purposes.

Interest in Further Methods

Several farm organizations have recognized the problem and have suggested averaging, as an alternate method of assessment. "Individuals should be permitted to average their incomes over a period of years for tax purposes. Such a procedure would treat farmers and others with widely fluctuating income more fairly."[3] "Discriminations against persons with irregular incomes should be removed as far as possible through equalizing tax burdens by means of some income averaging device. Averaging of income in carry-forward of losses for a period up to 3 years should be allowed."[4]

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[1] U. S. CONGRESS, HOUSE OF REPRESENTATIVES, 81st Cong., 2d Sess., Doc. No. 451. MESSAGE FROM THE PRESIDENT OF THE U. S. ON REVISION OF THE TAX LAWS; January 23, 1950, p. 7.

[2] The present law also permits the carry-forward of capital losses into the next 5 years until it is absorbed by net capital gains only, and losses of property not connected with trade or business arising from "fire, storm, shipwreck, or other casualty, or from theft." Because of the relative unimportance of these losses, they are not analyzed here.

[3] Correspondence from T. K. Cowden, then Director of Research, American Farm Bureau Federation, Chicago, quoting from resolutions in 1947.

[4] Correspondence from Lloyd C. Halverson, of the National Grange quoting from Proceedings of 1944 and 1947 of the National Grange.

Tax students also are interested in alternate methods of averaging incomes. Possible methods include averaging of income for 3 or 5 years, cumulative averaging, recomputation of tax based on past average income, and the Australian method of assessing the actual income at the rate applied to average income.

Experiences

Great Britain, Australia, and the State of Wisconsin have enacted some form of income tax averaging, but the only effective one at present applies to primary producers in Australia. Up to 1926,[5] Great Britain allowed averaging for about 30 percent of the income, which was not withheld at the source. Losses were averaged with income.[6] The British purpose in averaging was mainly concerned with assessment of certain income taxes not withheld rather than with inequity of annual assessment.

In Wisconsin a 3-year averaging provision (corporation and individual) was enacted, effective in 1928. In 1931 the legislature repealed the provision for a 3-year average, but averaging was continued until 1934. The tax base was the average of income and losses for the present year and the 2 preceding years. Before the depression of the early 1930's the liabilities were less than under annual assessment.

But during the depression the tax liability was higher than under annual assessment. "From the standpoint of the State the three-year average resulted in stabilizing income tax receipts; from the standpoint of the individual, however, it defeated one of the basic purposes of the income tax, namely, to place the burdens of the cost of Government on the ability to pay." [7]

The Commonwealth of Australia enacted an averaging provision beginning with the financial year 1922-23. The income of primary producers for the current and the 4 preceding years is averaged by applying the tax rate on the average income to current actual income. For example, assuming that the average income is $2,000 and current income $4,000, the rate will be based on the $2,000 average income, but it will be applied to the actual income of $4,000. The effect of this kind of averaging is to reduce the tax liability when actual income is above the average income and to increase tax liability when current income is less than the average income.[8] The Australian averaging system does not reduce the tax liability as much as does a moving average. Instead of changing both the base and rate, only the rate is changed.

Some Proposals Considered

An averaging proposal that is frequently mentioned would allow a taxpayer to average his past income and recompute his tax liabilities, for each of the preceding years included, by applying the rates to the average.[9] If the recomputed tax were smaller by 5 or 10 percent, the taxpayer would be entitled to a refund. The restriction of 5 percent for 5 years and 10 percent for 10 years would prevent the handling of a multitude of small claims. The averaging period could not include any year which had been averaged before. For example, a taxpayer could average his income for the years 1925 to 1935 and claim a refund; but his next averaging period could not include any of these years. As a means of simplifying the administrative procedure and cost, individuals with incomes below $5,000 might be allowed to carry over unused personal exemptions, although those with incomes above $5,000 could recompute their taxes based on average income and then apply for refunds.

It has been suggested that income can also be averaged by cumulating the taxpayer's income each year.[10] The cumulated income of a taxpayer includes interest on taxes paid.[11] The present value of taxes on the cumulated income would be derived from a specially constructed surtax table which would cumulate the tax liabilities, plus interest. For example, the present value of taxes on

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[5] Vickrey, William. Averaging of income for income-tax purposes. Jour. Polit. Econ. 47:380. 1939.

[6] Spaulding, Harrison B. The income tax in great britain and the united states. London, P. S. King & Son, Ltd. 1927. pp. 211-228.

[7] Wisconsin tax Commission. report, 1932, p. 180; and 1934, pp. 111-112; and Blough, Roy. averaging income for tax purposes. Accounting Rev. Vol. 20, p. 89. 1945.

[8] Rydge, Norman Bede, and Collier, J. B. commonwealth income tax acts, 1922-1929. Sydney, Law Book Co. of Australasia, 1929, pp. 83-111; averaging farmers' income for taxation purposes. Straight Furrow, February 16, 1948, p. 5; and Groves, Harold M. taxation in australia and new zealand. Natl. Tax. Jour. Vol. 2, p. 8, March 1949.

[9] Groves, Harold M. postwar taxation and economic progress. New York: McGraw-Hill Book Company. 1946. pp. 226-236.

TABLE 1.—*Computation of tax, using cumulative averaging*

	1941	1942	1943
Current income	$4,000.00	$6,000.00	$7,500.00
Cumulated income		4,000.00	10,009.00
Interest on taxes paid	.00	9.00	36.73
Total adjusted income	4,000.00	10,009.00	17,545.73
Present value of tax due	300.00	1,224.39	2,500.63
Minus present value of tax paid	.00	309.00	1,261.12
Tax due	$300.00	$915.39	$1,239.51

$12,000 of accumulated income (including interest) in the third year would be the liability on $4,000 in each of the 3 years, plus interest on the liabilities of the first 2 years. This surtax table would show the present value of tax due a hypothetical taxpayer who has a stable income. The present value of taxes paid is the sum of a taxpayer's past taxes paid, plus interest. The tax liability for each year is the difference between present value of tax due on accumulated income and present value of taxes paid. Computation of tax due under cumulative averaging with interest at 3 percent is shown in table 1.

The effect of this method of averaging is to adjust the current income-tax liability to that of a taxpayer who has a stable income. If current income should fall below the average, the average would be reduced with respect to previous years and, because of the progressive rate structure, the tax would be less than annual assessment. If current income should increase, the effect would be to increase the tax, although not so much as annual assessment. This method would have the advantage of reflecting ability to pay more closely than any other kind of averaging.

Evaluation of Methods

The above alternative possible methods of averaging are illustrated in table 2. Total liability is highest with carry-back of losses, followed by recomputation of tax based on average income, cumulative averaging, Australian, and finally 5-year moving average with the lowest total liability. Besides the indicated total liability, the relative amounts levied in any particular year are also important. For instance, in year 6, carry-back of losses and the Australian method indicate zero liabilities, whereas cumulative averaging would result in a refund of $173.89. A 5-year moving average, however, would result in a liability of $281.37. Also, in year 12, carry-back of losses would have the highest liability ($2,026.44), followed by $1,963.28 under cumulative averaging, $1,706.10 under the Australian method, and $891.94 with a 5-year moving average. Recomputation of tax based on average income would result in a refund of $125.38 for the 10 years 3 through 12.

In comparison with carry-back of losses, the 5-year moving average has the advantage of both a lower total liability and smaller liabilities during high-income years. The disadvantage is found in the tax liabilities during low-income or loss years. The Australian method reduces moderately the liabilities during years of high income, and it does not have the disadvantage of tax liabilities during loss years. The effect of cumulative averaging would be to reduce tax liabilities during some high-income years, but the principal advantage of this method would be the payment of refunds by the Treasury in 2 of 3 loss years. Recomputation of tax based upon average income would result in a moderate refund at the end of the 10-year period. The disadvantage of this is the delay in adjustment of tax liabilities for a rather long period.

The Wisconsin Tax Commission reported that the difficulty with the moving average in Wisconsin was that taxes were paid on incomes which no longer existed. In other words, the tax liability that may be in terms of amounts of farm commodities that may be exchanged for a dollar increased in relation to annual assessment. Therefore, it is desirable to consider alternate methods of income averaging also in reference to changes in the index of prices received.

The analysis in real terms requires that an index of changes in the value of the dollar be computed. In terms of the index of prices received, the value of the dollar increased from 67 in 1929, to 147 in 1932, and decreased to 35 in 1948. This means that in terms of physical quantities required to exchange for a dollar, in 1948, a farmer could pay

[10] VICKREY, WILLIAM. AVERAGING OF INCOME FOR INCOME-TAX PURPOSES. Jour. Polit. Econ. 37:379-397, 1939, and THE EFFECT OF AVERAGING ON THE CYCLICAL SENSITIVITY OF THE YIELD OF THE INCOME TAX. Jour. Polit. Econ. 43:275-277. 1945.

[11] The use of interest is justified if taxpayer A is able to shift forward his tax and delay payment until a later date. Taxpayer B pays his tax each year. Assuming A and B have equal total incomes, A could have invested the taxes paid by B and earned a return at current rate of interest.

TABLE 2.—*Alternate methods of averaging incomes for tax purposes, using 1949 normal and surtax rates* [1]

Year	Income	Tax				
		Annual assessment with carryback of operating losses	Five-year moving average [2]	Australian [3]	Cumulative averaging [4]	Recomputation based on average income [5]
	Dollars	*Dollars*	*Dollars*	*Dollars*	*Dollars*	*Dollars*
1	125	20.75	20.75	20.75	20.75	----------
2	550	74.70	47.80	74.70	92.47	----------
3	—100	0.00	26.23	0.00	3.53	710.97
4	2,675	462.68	130.81	444.05	466.71	710.97
5	5,325	948.00	281.37	883.95	931.12	710.97
6	—325	0.00	274.73	0.00	—173.89	710.97
7	8,125	1,487.00	552.70	1,430.00	1,528.84	710.97
8	—950	0.00	519.79	0.00	—282.56	710.97
9	2,525	433.64	513.98	441.87	455.88	710.97
10	6,325	1,262.60	552.70	1,113.20	1,396.87	710.97
11	6,900	1,414.40	853.05	1,283.40	1,458.41	710.97
12	9,075	2,026.44	891.94	1,706.10	1,963.28	710.97
Total	40,250	8,130.21	4,665.85	7,398.02	7,871.41	7,109.70

[1] The table is based on rates in effect in 1949. The income figures were selected to include operating losses as well as fluctuating positive incomes. The income is assumed to be from farming operations.

[2] Between years 1 and 4 the average was less than 5 years.

[3] The Australian method is not strictly comparable in the example because the Australian progression curve is smooth whereas the example is based on our step-bracket surtax rates.

[4] A special surtax table based on 1949 rates was constructed (but is not shown here) and the tax due was computed as in the example in table 1.

[5] The average income for years 3 through 12 is $3,957.50. The recomputed liability is $7,109.70 compared with $8,034.75 for carry-back of losses. The amount refunded (excess over 10 percent) would be $125.58.

equally well about twice the tax bill in 1929, or more than four times that in 1932. A method of averaging incomes should not result, in either high- or low-income years, in a greater real liability than does annual assessment. Thus, the inequity of annual assessment in real terms is reduced because declining real value of the dollar during prosperity partly offsets the increased liability with a progressive rate structure.

Real value of monetary unit based on index of prices received, selected years, 1929 to 1948 (August 1909-July 1914 = 100) is as follows: [12]

Year	*Reciprocal of prices received*
1929	67
1932	147
1936	82
1939	105
1948	35

Assuming that farm incomes fluctuate chiefly because of price changes, an averaging method that increases tax liabilities either in high-income or low-income years offers no advantage over annual assessment.[13] Because of the substantially larger liabilities during low-income years under a 5-year moving average, there does not appear to be an advantage in this method, in spite of a low total liability. The Australian method, except for 1 year has a lower real liability during years of positive incomes than annual assessment. In 5 of the income years, cumulative averaging would result in slightly higher real liabilities than annual assessment; but reductions in liabilities during low-income and loss years would seem to more than offset any increase [14] during years of high income.

[12] Computed by dividing numerator (August 1909-July 1914 = 100) by the index of prices received for selected years to give a measure of the value of each dollar in terms of prices received with a base of August 1909-July 1914. Index compiled by Bureau of Agricultural Economics and taken from Agricultural Statistics, 1949. p. 620.

[13] To the extent that farm incomes fluctuate because of unfavorable production conditions the above analysis would have to be modified but farm prices and incomes generally tend to increase and decrease together.

[14] HOLT, CHARLES C. AVERAGING OF INCOMES FOR TAX PURPOSES: EQUITY AND FISCAL POLICY CONSIDERATIONS. Natl. Tax. Jour. 2:349-350, December 1949, has criticized Vickrey's proposal because it does not take account of changes in the value of money, and effective tax rates fail to respond to an individual's ability to pay. From the preceding analysis, however, it appears that Vickrey's proposal responds more rapidly than do the others in changing effective tax rates. None of the averaging plans reviewed here takes account of changes in the value of money.

Another important aspect of these averaging methods is their feasibility from an administrative standpoint. Except for carry-back and carry-forward, income-tax returns now are normally closed each year (unless opened within 3 years, or, in fraud cases, any time). Besides loss carry-over, the proposal to recompute the tax based on average income would involve the least additional cost over present methods. As refunds could be claimed for each taxpayer at relatively long periods, the administrative cost in any year would be at a minimum. If the experience of Great Britain, Australia, and Wisconsin are any indication, it would seem that both a 5-year moving average and the Australian method can be administered, but it would be more difficult and more costly than recomputation of tax based on average income.

Cumulative averaging, however, would be extremely difficult and costly to administer. Because the averaging period is assumed to be indefinite, absolute accuracy in each return would be essential to successful operation. Otherwise errors would cumulate because of the use of interest in calculating present value of taxes due and present value of taxes paid. In cases in which the returns were post-audited with an additional tax assessed, the present value of taxes paid, and present value of taxes due, would have to be recalculated back to the year of additional assessment. A similar situation would arise with regard to refunds of taxes paid.

The selection of an averaging method involves a compromise, for none is entirely satisfactory to both taxpayer and administrator. Cumulative averaging would be difficult to administer; 5-year moving average results in higher liabilities than annual assessment during periods when ability to pay is smallest; recomputation of tax based on average income results in a refund only after a relatively long delay; and the Australian method results in only moderate reductions in relation to annual assessment during years of both high and low income. Recomputation of tax based on average income, relatively easy to administer, would perhaps afford farmers some relief without any increases in liabilities during low-income years.

Are Yearly Variations in Crop Yield Really Random?

By Richard J. Foote and Louis H. Bean

The study reported here is part of a research project, under the Research and Marketing Act of 1946, entitled Anticipating Year-to-Year Changes in Market Supplies Due to Changes in Yields Per Acre. One of the purposes is to learn whether the available records on crop yields per acre contain variations from year to year, or patterns of variations over periods of years, that might be usable in anticipating changes in per acre yields for a year or more in advance. Louis H. Bean here restates his views on the evidence of trends and patterns in crop yields and weather and as a first step in determining the reality of such trends and patterns, Richard J. Foote reports on the application of selected statistical tests to the fluctuations in corn yields and in a constructed series, concluding with a suggestion for a more appropriate statistical test.

Evidence of Trends and Patterns in Crop Yields and Weather[1]

IN CROP YIELDS AND WEATHER[2] I pointed to the existence of both weather and crop-yield patterns "that persist between one decade and another, between alternate decades or even longer intervals." A number of illustrations were presented "as preliminary evidence of the existence of patterns or yield variations over a period of several years that tend to be repeated 9 to perhaps 11 years later and that undoubtedly are caused by combinations of weather factors that also tend to take on pattern variations over several seasons, to be repeated 9 to 11 years later. The individual patterns in yearly yields and in seasonal weather may embrace 3 or 4 years, or as many as 10, and possibly more. These longer patterns, both by months and seasons, are here emphasized because of the greater improbability that they represent merely chance variations. If they are not due to chance variations but to terrestrial or extra-terrestrial weather-making forces, it is highly important that these forces be surmised and discovered for otherwise successful season-to-season weather and crop forecasting will not be possible."

"The search for methods of long-range season-to-season weather and crop forecasting is being stimulated by the U. S. Department of Agriculture, the Weather Bureau now in the Department of Commerce, and other agencies. Progress to date has been recorded in the 1941 yearbook of the Department of Agriculture.[3] As yet there is no direct approach known to scientists in this field of forecasting enabling them to forecast for more than a few days in advance." Writing today we might possibly change the last few words of this statement to "a few weeks in advance."

This conclusion followed: "Meteorologists believe the most rapid and certain progress can be made by studying atmospheric phenomena directly, and discovering and measuring the physical factors that cause both persistent tendencies and changes in weather over long as well as short periods. The approach presented in this publication is statistical, but its object is the same as that of the physical studies of the meteorologists—to hasten the day when season-to-season long-range weather and crop-yield forecasting will be possible. If statistics can demonstrate the existence of weather patterns and can determine what they are, that in itself will be a long step toward the solution of the ultimate problem."

Since reporting on these findings, I have probed more extensively and have observed additional features with regard to the repetitive character of both trends and patterns in crop and weather data, here and abroad. Much of this probing has been done as a hobby without benefit of an official research project and is, therefore, not ready for formal presentation. But these recent probings confirm the observations made during the 1930's and the research suggestions offered in 1942. I would now repeat them with greater emphasis.

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[1] By Louis H. Bean.

[2] BEAN, LOUIS H. CROP YIELDS AND WEATHER. U. S. Dept. Agr. Misc. Pub. 471. 1942. pp. 1-5.

[3] UNITED STATES DEPARTMENT OF AGRICULTURE. CLIMATE AND MAN. Yearbook of Agriculture. 1941.

In spite of the fact that we live in a universe of law and order, fluctuations in both weather and crop yields, whether short- or long-range, are almost universally looked upon as matters of chance. Practically all statistical studies that have raised the question of regularity in fluctuations in crops and weather conclude negatively; that is, they find that fluctuations of crops and weather are essentially similar to what might be expected in series of random numbers.

My observations with regard to the existence of trends and patterns in both monthly and yearly data make it difficult to accept this common attitude. In fact I doubt that the commonly used statistical tests of whether a time series is random are adequate for our problem.

This doubt is fortified by the probing we asked Richard Foote to undertake and the results given in the preliminary report beginning on this page. He tested, as others have done, whether the fluctuations in the yield per acre of corn in the United States conform to what might be expected of a random series. He finds, as others have done, that they do. He then applies the same tests to a constructed series that contains several repetitions of a trend, a 13-year pattern, and an extraneous element added at 10-year intervals. The constructed series contained 80 observations, to correspond to the yearly range of available crop and weather data —say 1870 to 1950. Foote finds that this series, too, according to the available tests, does not differ significantly from what one might expect of a random series.

Obviously we need other tests that will be more efficient in separating that which is random from that which is orderly. To indicate the nature of the tests that seem to be called for, Foote performed an additional analysis of fluctuations in corn yields. On the basis of my manipulations of that series, in which a graphic procedure for isolating trends and patterns in four contiguous periods is used, he finds the six correlation coefficients that are possible with four series not statistically significant. (They range between 0.08 and 0.63.) But after the elimination of flexible trends, separately determined for each of the four periods, he reports that the resulting correlation coefficients range between 0.78 and 0.94—all "highly significant based on the usual tables." Obviously the significance of these repeating long-range patterns depends on the flexibility and "reasonableness" of the trends. The trends themselves that emerge in the graphic search for correlated patterns also show a high degree of similarity. Foote concludes that the additional tests we need should deal with the significance of correlations between observed patterns after allowing for the characteristics of the trends that are used to reveal them.

Application of Certain Statistical Tests to Corn Yields, 1866-1949[4]

Frequency Distributions

The first step in this work was to ascertain whether corn yields are normally distributed.

Table 1 shows the frequency distributions by classes for average corn yields in the United States as reported, 1866-1940, and for specified States after adjustment has been made for estimated effects of the use of hybrid seed, 1866-1943. In each case, data were tabulated for four subperiods of approximately equal length. Except for a slight rising trend in some areas, the distribution for the subperiods did not differ significantly from the distribution for the entire period. It appeared that combining the subperiods would result in no great loss of information. In some instances, data in this table have been condensed from the original tabulations.

TABLE 1.—*All Corn: Frequency distributions for yields per harvested acre, by class intervals, United States and specified States*

Class interval	United States[1]	Illinois	Iowa	Wisconsin	Missouri
Bushels/acre	Frequency				
5.0- 9.9					2
10.0-14.9					1
15.0-19.9	4		2	1	6
20.0-24.9	21	8	1	6	9
25.0-29.9	46	13	5	12	33
30.0-34.9	4	14	15	26	22
35.0-39.9		24	23	34	5
40.0-44.9		16	24		
45.0-49.9		3	7		
50.0-54.9			1		

[1] When a narrower class interval is used, the United States series resembles more closely the State distributions.

Corn yields appear to be highly skewed. Extremely low values occur fairly frequently, but high yields are generally not much above the class interval that contains the highest frequency. This indicates that, in these areas, weather conditions

[4] By Richard J. Foote.

generally are either close to optimum or that some unfavorable factors are practically always present. Occasionally, however, conditions are such that yields are cut very materially.

Because the yield distribution appears to be non-normal, all of the tests used were non-parametric; that is, they make no assumption about the parameter values of the frequency distribution from which the sample is drawn.

Tests Dealing with Departures from Randomness

A. Application of the theory of runs.—The "theory of runs" provides a method for testing the hypothesis that a set of time-ordered observations constitutes a random sequence. The test discussed here has been taken from Hoel.[5] In this test, the positive deviations from a trend line or from the mean are designated by "a" and the negative deviations by "b," and the number of runs or consecutive sequences of a's and b's are counted. As the length of the runs increases, the total number of runs decreases. By computing the probability of obtaining a given number of runs or less, we obtain an index of the randomness of the sequence. The computations are greatly simplified if a table giving logarithms of N! is used. (See Grant[6] for such a table).

Two tests were applied to corn yields in the United States. The first was based on deviations from a 9-year moving average, using data for the original series for 1866-1949. The second was applied to actual data for the period 1866-1940. Use of actual data after 1940 appeared to be inadvisable because of the sharp upward trend in yields. Use of deviations from trend can be justified since we are not attempting to learn whether a trend exists but rather whether the deviations as such are random. The yield series, together with the moving average, is shown in the upper part of figure 1. These tests gave probabilities of 0.075 and 0.091, respectively. The results indicate that if repeated samples of this size were drawn from a random series, we would expect to get as few runs as shown by the corn series 7.5 and 9.1 percent of the time, respectively. If the 5-percent point is taken as the level of significance, corn yields do not differ significantly from a random series based on these tests. However, the results are close enough to the 5-percent point to warrant additional investigations.

B. Application of the theory of phase length.—Wallis and Moore[7] developed a test based on the number of phases of various lengths expected in a random series. A phase is defined as the interval between consecutive turning points. This test is not sensitive to trend; that is, it may classify a series as random even though there is a persistent trend or long-term oscillations. For this reason, the test is not conclusive in indicating that a series does not differ significantly from a random one; but if non-significant results are obtained, it does indicate that non-random factors are of secondary importance.

The only restriction placed by this test on the nature of the probability distribution is that the probability of two consecutive observations being identical be infinitesimal. This will not necessarily hold for crop yields as published. A method of adjusting for "ties," (that is, consecutive items having the same value) is shown in their paper. This test was applied to corn yields in the United States for the period 1866-1949. The following results were obtained:

Phase duration—Years	Observed Frequency	Expected Frequency	(Observed-expected)^2 ÷ expected
			0.09
1	35	33.3	.88
2	18	14.4	.08
3 or more	5	5.2	
			$\chi^2_p = 1.05$

This yields a probability of 0.61. Thus, if we drew repeated samples from a random series, we would expect to get, 61 percent of the time, a divergence as large as that shown for yields of corn. Therefore, based on this test, we have no reason for assuming that corn yields are non-random.

Timoshenko[8] has suggested that small ripples be eliminated before this test is applied. He suggests eliminating all "cycles" for which the maximum

[5] Hoel, Paul G. introduction to mathematical statistics. New York. 1947. pp. 177-183.

[6] Grant, Eugene L. statistical quality control. New York. 1946. pp. 547-551.

[7] Wallis, W. Allen, and Moore, Geoffrey H. a significance test for time series. Natl. Bur. Econ. Research. Tech. Paper 1. 1941.

[8] Timoshenko, V. P. variability in wheat yields: part i. cycles or random fluctuations? Food Research Inst. Wheat Studies. 18:291-377. 1942.

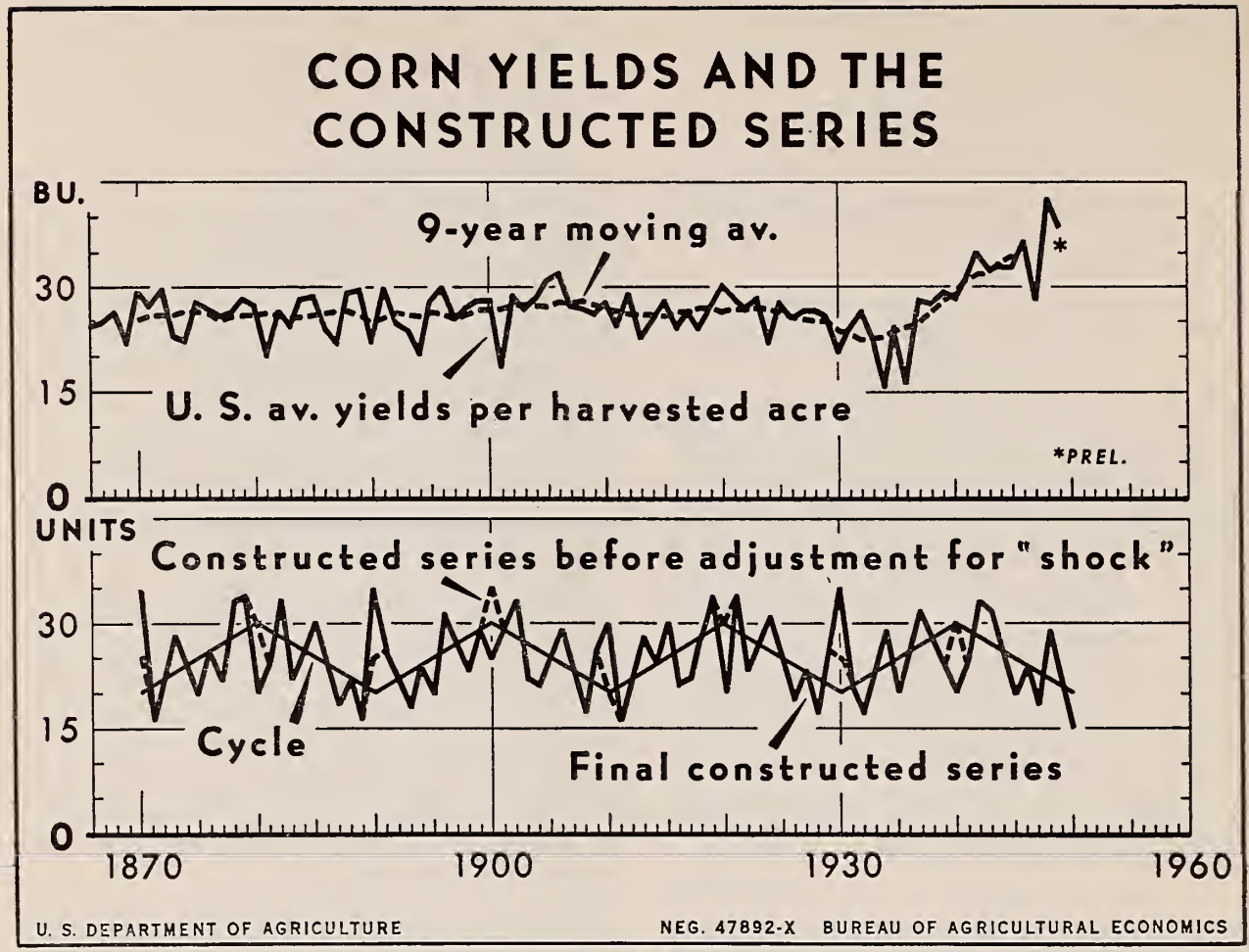

FIGURE 1.

between two successive minima is less than ½ standard deviation above both minima. When this was done for the corn series; P (χ^2_p) was reduced to 0.36. But this is not valid since some of the expected phases are only of "ripple" magnitude.

These two analyses yielded average phase lengths of 1.48 and 1.65 years, respectively. The expected average duration of phases in a random series is 1.49 years.

Timoshenko also computes the average amplitude of cycles, but this appears to be mainly of value in comparing various series. He gives no tests of significance. Kendall[9] indicates that methods based on the study of oscillations in the original series are not satisfactory in ascertaining the nature of an oscillatory system. The use of a correlogram, discussed below, gives more reliable results, at least in those cases in which a sufficiently long series is available.

Attributes of a Random Series

For a random series, the serial correlation coefficient r_1' for first differences should equal −0.5 and the correlation between $x_{i+1} - x_i$ and x_i should equal −0.71. Scatter diagrams indicate that these are approximately true for yields of corn.

Autoregressive Series and the Correlogram[10]

Two types of oscillations in time series have

[9] KENDALL, M. G. CONTRIBUTIONS TO THE STUDY OF OSCILLATORY TIME-SERIES . Natl. Inst. Econ. and Social Research, England. Occasional Papers IX, 76 pp. Cambridge. 1946.

[10] For a more detailed discussion of this subject see FOOTE, RICHARD J. THE STATISTICAL ANALYSIS OF CYCLES OR OSCILLATIONS IN TIME SERIES. Bur. Agr. Econ. November, 1950.

received wide attention in the literature: (1) harmonic or periodic and (2) autoregressive.

Harmonic cycles are characterized by regularity in time; that is, their peaks and troughs recur at regular intervals. A series made up of a number of harmonics of varying lengths may give a jagged appearance, particularly if large superposed errors are present, but the separate cycles can be readily unscrambled by use of a periodogram, provided sufficient data are available.

Autoregressive series are not "cycles" in the strict sense of the word, since their peaks and troughs do not recur at regular intervals. They are characterized by frequent variations in both period and amplitude. In many cases, however, fluctuations around the up-and-down movement for any given oscillation are fairly smooth. Autoregressive series can be represented by nonperiodic mathematical models and can be analyzed by means of a correlogram.

Because of the unsatisfactory results obtained when periodograms were applied to economic, meteorological, and agricultural data, Yule[11] developed a new concept known as an "autoregressive series." In such a series, the assumption is made that, once a disturbance has occurred, certain cyclical processes are set in motion which will continue, subject to a large or small degree of damping, until upset by another disturbance. Yule gave as his initial example a freely swinging pendulum at which boys throw peas. It is immaterial to the theory whether the pendulum is initially in motion or at rest. In the economic field, a similar example is perhaps given by the advance in coffee prices late in 1949. A rumor of severe frost damage in Brazil caused these prices to advance. With the price rise, dealers and consumers began to accumulate stocks, which caused a further advance in price. Eventually, stocks appeared to be large enough, buying slowed down or stopped altogether, and prices began to decline. The extent of the initial decline would depend on the degree of actual or estimated damage to the crop, the extent to which dealers and consumers decided to reduce their inventories, and any changes in other price-making factors which had occurred since the date of the original rumor. Several highly damped oscillations might occur before prices reached equilibrium.

A correlogram can be used to test whether systematic oscillations of either the harmonic or the autoregressive type prevail in a time series. If in a time series, r_1 is defined as the simple correlation between the original data and the same data lagged by 1 time unit, r_2 is the simple correlation between the original data and the same lagged by 2 time units, and, in general, r_k is the simple correlation between the original data and the same lagged by k time units, then the correlogram consists of the r_k plotted against k.

A test for systematic oscillations is not the same as a test for randomness, since a non-random series is not necessarily oscillatory. On the other hand, one of the characteristics of a random series is that the serial correlation coefficients be zero except for sampling variations.

Rohloff[12] computed a correlogram for corn yields in the United States, using data for the period 1866-1947. He used two sets of data: (a) deviations from a third-degree polynomial and (b) deviations from a 9-year moving average. Neither gave any evidence of an oscillatory pattern or of significant deviations of the serial correlation coefficients from zero. Examination of the fit of the polynomial indicated that the sharp rise in yields since 1940 was primarily responsible for the significant reduction in deviations by the use of the third-degree term. The polynomial gave a poor fit during most of the entire period. Because of this, some experimental work was done with the corn-yield data for the period 1866-1940 with no adjustment made for trend. This also yielded unsatisfactory results. Hence, for the computations discussed below, deviations from the 9-year moving average from 1870 through 1945 were used.

The Autoregression Equation

Autoregressive series can be fitted by equations of the following type:

$X_t = -a_1 X_{t-1} - a_2 X_{t-2} - \ldots - a_p X_{t-p} - a_o + \epsilon_t$, where ϵ_t represents the disturbance or shock. This is called an autoregression equation, since the

[11] YULE, G. UDNEY. ON A METHOD OF INVESTIGATING PERIODICITIES IN DISTURBED SERIES, WITH SPECIAL REFERENCE TO WOLFER'S SUNSPOT NUMBERS. Royal Soc. London Phil. Trans. A226, pp. 267-298. 1927.

[12] ROHLOFF, A. C. STATIONARY TIME SERIES TECHNIQUES APPLIED TO U. S. CORN YIELDS, 1866-1947. Unpublished manuscript. 1949.

value of X at time t depends mainly on previous values of the same series.

If the analyst has reason to think that he is dealing with an autoregressive series, Kendall[13] suggests the following method for determining the number of terms needed in the equation. Consider the lagged values of the original series as the variables X_1, X_2, X_3 . . . up to X_5, say. Let X_0 be the original series. Then X_1 represents X_0 lagged by 1 year, etc. (X_0 corresponds to X_t in the above equation, X_1 to X_{t-1}, etc.) Compute the following simple and partial correlation coefficients: r_{01}, $r_{02\cdot1}$, $r_{03\cdot12}$, $r_{04\cdot123}$, $r_{05\cdot1234}$. Also compute the following quantities: $1 - R^2_{0\cdot1} = 1 - r^2_{01}$, $1 - R^2_{0\cdot12}$, $1 - R^2_{0\cdot123}$, $1 - R^2_{0\cdot1234}$, $1 - R^2_{0\cdot12345}$. At some point the partial correlation coefficients will approach zero except for sampling errors, and the $1 - R^2$'s will become relatively constant. If this point is reached at $r_{03\cdot12}$ and $1 - R^2_{0\cdot123}$, for example, then a 2-term equation is enough.

Despite the fact that the correlogram gave no evidence of an oscillatory pattern, these values were computed for the corn-yield series, using deviations from the 9-year moving average. The following results were obtained:

Order of partial r	Value of partial r	Value of $1 - R^2$
01	— 0.065	0.9958
02.1	— .1478	.9741
03.12	— .2035	.9338
04.123	— .2247	.8866
05.1234	— .184	.8566

These computations indicate that even a 5-term autoregression equation would "explain" less than 15 percent of the variation in the original series. This is in contrast to the sample which Kendall cites—namely, sheep numbers in England—for which a 2-term equation would explain 75 percent of the variation. If repeated samples of this size were drawn from a population for which the true correlation was zero, multiple correlations of the size obtained for the corn-yield series would be expected to occur slightly more than 5 percent of the time. So they are not significant, according to the usual criterion. The partial correlations also do not differ significantly from zero. These results confirm the evidence given by the correlogram that significant *oscillatory* patterns do not prevail in the United States corn-yield series. But they do not rule out the possibility of the existence of other types of repeating patterns.

Analysis of Other Types of Patterns in Time Series

Under an earlier research project in the Bureau of Agricultural Economics, some work was done on the statistical analysis of patterns in time series which cannot be represented by any simple type of mathematical equation. Some of the patterns found in yield series are similar to the patterns formed by the combination of a number of harmonic series of regular length, but they do not reoccur with sufficient regularity over the entire series to indicate a compound harmonic type. Sanderson[14] discussed the probability of obtaining such patterns from random series under various assumptions. In the two test cases which he considers in detail, based on first differences and actual data, respectively, of yields of corn in the United States, 1866-1938, the extent to which patterns were repetitive did not differ significantly from what could have been expected if the yield series were random.

Application of These Tests to a Constructed Series

The fact that these tests indicated no significant deviations from randomness for yields of corn is, of course, no definite proof that the corn-yield series is a random one. In general, tests of significance can merely indicate whether a given series does or does not differ significantly from a certain test series, in this case a random one. The analyst can never *prove* that the given series is random. In view of this fact, it is sometimes useful to apply tests of significance to constructed series to see whether the results differ from what might be expected before the tests were applied. A series was constructed, based on a regular pattern superimposed on a regular cycle, with a "shock effect" added to cover the cycle partially. The pattern used is similar to those discussed by Bean for yields of specified crops. The lower part of figure

[13] KENDALL, M. G. OSCILLATORY MOVEMENTS IN ENGLISH AGRICULTURE. Royal Statis. Soc. Jour. Pt. II, 106, pp. 92-117. 1943.

[14] SANDERSON, FRED H. RESEARCH PROJECT ON "REPEATED PATTERNS" IN WEATHER AND CROP SERIES. Unpublished manuscript. 1940.

1 shows the final series, together with the cycle. The observations have been labeled as specific years to facilitate plotting them along with the corn yields; but such labels are purely arbitrary. As this series would be essentially predictable, given the cycle and the superimposed pattern, it is, by definition, non-random.

Application of the theory of runs to the constructed series gave a probability of 0.089, about the same as for the corn-yield series.

Application of the theory of phase length gave the following results:

Phase duration—Years	Observed Frequency	Expected Frequency	(Observed-expected)^2 ÷ Expected
1	26	32.5	1.3
2	21	14.1	3.4
3 or more	4	5.0	.2
			$\chi^2_p = 4.9$

As with the corn-yield series, fewer 1-year phases and more 2-year phases than expected were found; the number of phases of 3 or more years were about equal to expectations. A probability of 0.09 was given, materially less than the 0.61 obtained for yields of corn, but still not significant if the 5-percent point is taken as the acceptance level.

The above indicates that, although based on certain commonly used tests, the yields of corn do not deviate significantly from a random series, they also probably would not deviate significantly from a series of the type used in the constructed example. Thus it appears that these tests are not sensitive in distinguishing between these two types of series—that is, a random one and one based on a composite of a regular cycle plus regular patterns.[15]

New Test of Significance Needed

In analyzing crop yields for repeating patterns of the type discussed by Bean, it frequently is necessary to fit rather flexible trends to bring out the patterns. If such trends are fitted in such a way as to make the repeating patterns, based on deviations from them, as nearly alike as possible, the usual tests of significance for the correlations between patterns in two or more different periods do not apply. The following method would yield a valid test under such circumstances.[16] The method is outlined in mathematical terms in the next paragraph but is discussed on a less mathematical basis in the paragraph following that.

Proposed Test: Let the yield series be represented by a set of x_{ij}, where i indicates the period and j indicates the year within the period. Let the r_{ik} represent a set of simple correlations of the data in each period with the corresponding data in each of the other periods. If there are m periods, there will be $\frac{m(m-1)}{2}$ such correlations. We shall now fit sets of y_{ij} such that either the minimum absolute value of the r_{ik} or the average absolute value of the r_{ik} when based on $x_{ij} - y_{ij}$ is as great as possible. The y_{ij} will represent the trend values for each period and could be fitted with or without restrictions.[17] By determining the expected distribution of the r_{ik} when the x_{ij} are random and independently distributed, a test of significance for such correlations would be obtained. Allowance might also need to be made for the fact that the number and length of the periods and the starting dates all are chosen in such a way as to make the r_{ik} as large as possible. The mathematical derivation of this distribution will be complicated by the fact that yield series, in general, have a skewed rather than a normal distribution and the test should be applicable to such series. If the trends found in the yield series are themselves correlated from period to period, this might form a desirable restriction in fitting the y_{ij}, so that a more sensitive test would be obtained.

In non-mathematical terms, this test involves the following: Suppose we have data covering 80 years and we believe that patterns, in terms of deviations from certain trends, repeat at 11-year intervals. If the first pattern starts within the first 3 years of data, we would have 7 such complete repe-

[15] The computation of either a correlogram or a periodogram for the constructed series probably would have revealed the cycle used and possibly the shock effect. But trend factors which are assumed to prevail in the crop-yield series are of a non-oscillatory nature and thus were not revealed by the correlogram. The nature of the trend factors for the yield series is indicated in somewhat more detail in the next section of this paper.

[16] This method was suggested by Glenn Burrows, Bureau of Agricultural Economics.

[17] It should be noted that this problem differs from the usual one of fitting trends or polynomials where the best fit for the data as such is desired.

titions. If we correlated the first 11 years of data, in terms of deviations from trend, with the second 11 years of data, the third, the fourth, etc.; and the second 11 years of data with the third, the fourth, the fifth, etc.; using all possible combinations; we would have 21 such correlations, each based on 11 observations. The trends could be fitted either mathematically or graphically. As major interest is centered on fitting the trends in such a way as to bring out the repeating patterns, it probably would be easier to fit them graphically than mathematically. But if we wish to obtain the expected mathematical distribution for such correlations, the trends would have to be fitted by mathematical methods. The use of orthogonal polynomials might well prove useful. After working out the expected distribution for such correlations, we would have a means of testing the significance of the 21 correlation coefficients after allowing for the characteristics of the trends that were used to obtain the deviations from trend which are actually correlated. It is probable that considerable time would be required to develop this distribution. Only after it had been developed would we know how much error is involved in using the standard tests of significance when dealing with correlations based on deviations from trends fitted in such a way as to maximize the correlations.

Conclusions

Based on several standard tests, yields of corn, after allowing for trend, give no evidence of departing significantly from a random series. However, using the same tests, a constructed series based essentially on a regular pattern superimposed on a regular cycle also gave no evidence of significant departures from a random series. The pattern used for the constructed series resembles those which Bean believes he has found in crop-yield series. Thus, the standard tests do not appear to be sensitive in distinguishing between a random series and one made up of repeating patterns of the type used in the constructed series. An improved test is outlined, but to work out the details substantial mathematical work would be required.

The authors and certain other statisticians are convinced that the evidence which Bean has accumulated so far warrants additional work in this field. Even if the chance of success is relatively slight, all possibilities should be followed up as even moderately improved success in forecasting crop yields would bring great economic benefit.

Book Reviews

The Economics of Collective Action. *By* JOHN R. COMMONS. The Macmillan Company, New York. 414 pages. c1950.

THIS VOLUME by a man who spent most of his life on the battlefronts of economic conflict is the last of three significant books in which he undertook in his later years to construct a science of political economy that gave due weight to what he had seen with his own eyes. Along with all other economists, he found the economy complex and changing; in fact, he found it even more complex and changing than did most of them because he participated more in efforts to change it. The first two books explaining his volitional theory of economics (*Legal Foundations of Capitalism* and *Institutional Economics*) were not easy reading. But this was due in no way to any inability on his part to state clearly a simple idea; it was due rather to the fact that he was dealing with ideas that are not simple. Partly because of the understanding and untiring efforts of the editor, Kenneth H. Parsons, the present volume is much more easily read, and for this reason alone should result in a more widespread understanding of the work of this really great American economist.

The book consists of 17 short chapters, organized into four parts, as follows: (1) Economic Activity, (2) Simplified Assumptions, (3) Relativities, and (4) Public Administration in Economic Affairs.

Under Economic Activity, Commons starts again with the fact that must be evident to all thinking economists. The fact is that collective action is now dominant in America and in all other important national economies throughout the world. Its principal forms in America are corporations, labor unions, and political parties.

If economic analysis is to be directed to real problems of policy instead of merely to the solution of logical problems of mathematics, it cannot escape the analysis of collective action and the choice of alternatives available under collective action. Commons understands economic policy to be purposeful political economy, not merely automatic atomistic economics. Purposeful political economy is a volitional process, not a natural equilibrium. The mental tools required for investigating and understanding this process can be reduced by abstraction to no less than five, which he calls "Simplified Assumptions." He names them Sovereignty, Scarcity, Efficiency, Futurity, and Custom.

In his discussion of "Relativities," he says in effect that any economic theory that is intentionally restricted to the analysis of scarcity deals with only one of these five functional variables and usually results in what he calls a "part-whole fallacy." It blurs the vital distinction between use-value and scarcity-value, between wealth and assets, between goods and ownership of goods. The real practical truth is the whole truth; not an abstract part-truth. Not all forms of collective action can be identified as monopoly. He calls "reasonable value" the "ethical culmination of economics"—by which is meant that most actual or real prices in the modern world do not have merely economic dimensions, but also objective ethical and political aspects. This means that to understand them and the policies responsible for them the economist cannot wall himself off from the other social sciences.

In a period characterized by control economics, the most serious blindness is the illusion that it is possible to return to the individualism of the eighteenth century. "Instead of the traditional equilibrium between equal individuals of economic theory, the alternatives today are between an economic government based on balance of power between self-governing corporations and unions, and a suppression of both organizations, or their leaders, by military power." Commons agrees with neither those seeking extreme individualism nor the advocates of dictatorship. He holds that the first goal is an inaccessible alternative; and that the latter, whether of the right or the left, is not the only remaining available choice. Another is what he calls "collective democracy," as distinguished from the individualistic democracy of Adam Smith. In his discussion of Public Administration, he recommends the device of the advisory committee of the leaders of groups having con-

flicting interests as an effective means of retaining democracy in the governmental process.

Believers in economic law, or in simple solutions like either laissez-faire or the deficit spending formula, will get little comfort from this volume. The laissez-faire boys generally have already become pessimists who see America headed straight down the road to serfdom. The extreme Keynesians are already extreme optimists who seek only the authority to regulate the money switch. Commons' students are neither pessimists nor optimists. They are serious but not without hope, because they see nothing inevitable about serfdom, they have never had any illusions about the inexorability of the price mechanism, and know that the extreme Keynesians (not Keynes himself) are guilty of the part-whole fallacy. They know, also, that they have to work for the kind of economy they want—that it will not result from any automatic natural forces.

Agricultural economists who seek "to implement the search of mankind for liberty, security, justice and equality" cannot afford to be without this volume. It is the one to read first in order to become acquainted with Commons. Economists of the future will be reading it when most of the current products that represent a cultural lag from an outmoded past are forgotten. Besides the four parts, too briefly described in this review, the book includes: (1) A biographical sketch of Commons by Selig Perlman, (2) an editor's preface by Kenneth H. Parsons, (3) an appendix on Commons' Point of View, also by Parsons, (4) two additional appendices, and (5) an extended bibliography of Commons' writings. Finally, those who knew him will appreciate the excellent reproduction in color of his portrait by Christian Abrahamson, which is also included by virtue of the generosity of a friend of Commons.

Bushrod W. Allin

Economic Fluctuations in the United States, 1921-1941. By LAWRENCE R. KLEIN. John Wiley & Sons, Inc., New York. 174 pages. 1950. (Cowles Commission Monograph 11)

THE TITLE of this book is misleading, for the nonmathematical reader will not find a recognizable description or explanation of business cycles during the interwar period. Even the mathematically sophisticated are given little basis for appraising the significance of the author's complete model. Its relevance to the field of discourse of Schumpeter, Mitchell, Slichter, and Hansen is by no means obvious—primarily because the author himself does not indicate such a connection.

Actually, the book is an exercise in econometric model building. The first chapter is a very brief exposition of the Cowles Commission approach to economic analysis. The economic system is regarded "as describable by a set of simultaneous equations expressing all the inter-relationships among the measurable economic magnitudes which guide economic behavior." In addition to "endogenous" variables which are mutually determined at a given time, the system includes values of the same variables for previous periods and "exogenous" variables, which may be determined by "natural, technological, sociological, political, or institutional forces which are assumed here to be non-economic." In principle, the system as a whole cannot be accurately described by calculating least-squares estimates of the separate equations. For one thing, different least-squares estimates are obtained for different choices of the "dependent" variable. Furthermore, unless we know a good deal about the other equations in the system and are willing to make some assumptions about the nature of the unexplained residuals or "disturbances," we shall not be sure whether an equation containing (for example) price and quantity variables is a demand curve, a supply curve, or some uninterpretable combination of the two. This is the "identification problem," which has received much attention from members of the Cowles Commission staff in recent years. The terminology is new and the current mathematical treatment more elegant, but the basic problem was well known to agricultural price analysts in the 1920's (see especially Elmer Working's article, "What do 'Statistical Demand Curves' Show?", *Quarterly Journal of Economics*, February 1927).

In view of these difficulties which are inherent in a single-equation approach, the author concludes that it is necessary to use a maximum-likelihood method of estimation which treats the set of equa-

tions as a unit and avoids the least-squares problem of choosing one variable in each equation as the "dependent." (The statistical theory underlying Klein's method of estimation is developed in Cowles Commission Monograph No. 10, to be reviewed in an early issue of this journal.)

The second chapter presents various hypotheses as to the major relationships involved in economic fluctuations and expresses them in mathematical form. There are sections on "The Theory of the Firm" and "The Theory of the Household." The mathematical formulations lay considerable stress on anticipated prices and profits as guides to economic behavior. In the statistical portion of the book anticipations are assumed to be functions of (recent) past levels and rates of change of the variables.

Chapter III takes what is (for this book) the final step of representing the variables of economic theory by statistical series and proceeding to estimate the "structural coefficients" of the equation system. These correspond to the net regression coefficients of the least-squares method. The final model of the U. S. economy contains 12 simultaneous equations in terms of 12 "endogenous" and 28 "exogenous" and lagged "endogenous" variables. Least-squares estimates of the same equations are also presented. At this point, the author dismisses the whole problem of interpreting his results with the following sentences.

"There are few general comments that can be made upon a comparison between the two different methods of estimating the parameters of Model III. It is left to the reader to form his own judgments on the comparison."

As the book is primarily an exercise in the use of a particular method of analysis, it should perhaps be reviewed only in terms of its method. A dispassionate discussion of the Cowles Commission method is contained in the *American Economic Review* (Vol. XXXIX, Nos. 3, May 1949, pp. 47-88) and a livelier one in the interchange between Vining and Koopmans in *The Review of Economics and Statistics* (Vol. XXXI, No. 2, May 1949). This review confines itself to narrower observations:

(1) Much is made of the interdependence of the various elements of the economic system as a justification for the author's approach. However, of the 12 simultaneous equations, 7 contain only two "endogenous" (mutually determined) variables; 4 contain three, and 1 contains a single "endogenous" variable. Thus, only 15 of a theoretically possible 132 "structural coefficients" between "endogenous" variables are considered important enough to measure. This makes the method more wieldy, but it also reduces the intuitively measureless gulf between single-equation and multiple-equation approaches to finite proportions.

(2) A comparison of these 15 structural coefficients with their least-squares counterparts shows more similarities than differences. Thirteen of them are within two standard errors of the least-squares net regression coefficients (10 of them within one standard error). Whether these differences lead to strikingly different conclusions about business cycles the author does not say. The reviewer is led to conclude, however, that least-squares estimates will approximate "structural coefficients" within the limits of sampling error in a good many (but not all) practical situations.

(3) The author's method shares almost all of the problems of the single-equation approach, including choices of variables, functional forms, and methods of dealing with trends and serial correlation. Moreover, as the author points out, "multicollinearity was and still is a problem. When several economic variables move together in the same general time patterns, we shall not be able to measure their separate influences in the equations of the system." As business cycles are measured and identified by the fact that a great many economic variables move together in the same general time patterns, this problem is here to stay. Its importance may be reduced in some cases in which the significant relationships can be stated in terms of year-to-year changes rather than original values of the variables. This possibility is not discussed.

The book will be of primary interest to a limited audience of mathematical economists and econometricians. Klein himself is one of the ablest young econometricians in the country, and his book (written mostly during 1944-47) gives ample evidence of the fact. The book's main shortcoming is its failure to interpret the statistical results in a way which would gain it a broader and more sympathetic audience and establish it as a substantive contribution to business-cycle analysis as well as a methodological experiment.

Karl A. Fox

Trade and Agriculture: A Study of Inconsistent Policies. By D. Gale Johnson. John Wiley & Sons, Inc., New York. 198 pages. c 1950.

THE GREAT CONTRIBUTION of the Schultz school—if we may speak of such—in agricultural policy has been in reemphasizing economic use of resources throughout a period when the public mind has been almost wholly preoccupied with price supports. That existing programs show little evidence of the efforts of Schultz and his colleagues by no means implies that they have been ivory-towered. They have urged a variety of concrete proposals designed to stabilize farm prices and improve farm incomes while promoting rather than hindering sound adjustments in resource use.

Gale Johnson's *Trade and Agriculture* follows in this tradition. Those who have read his *Forward Prices for Agriculture* will find much familiar ground recultivated; those who have not read it will find in the present volume a pretty satisfactory summary of its major arguments. The author here extends his thinking on farm policy into the context of international trade policy. The extension reaffirms his criticisms of present farm policy and imposes no substantial modifications of his proposals in this field.

He again urges "forward prices," implemented through direct-payment and storage operations, to give farmers a better basis for planning in good times and to reduce their income losses in bad times. But he rejects price programs as a device for raising farm income. To do this he advocates a marketing-and-consumption program, plus a "conversion" program for shifting surplus labor out of agriculture. He stresses the importance of maintaining high national employment as a basis for achieving either our agricultural or our trade objectives.

In retilling this ground, the author elaborates the difficulties that present farm programs impose on our policies for promoting freer international trade, and points out the ways in which his own proposals avoid such difficulties. He is critical of our trade-policy actions mainly for having gone too far in compromising freer-trade objectives in order to avoid agricultural political opposition.

But he is no mere exponent of international laissez faire. He criticizes also the too-doctrinaire mentality that has prevented the devotees of liberal policy from accepting the desire of agriculturists to protect themselves against instability in world markets. He has a program in this area, too—internationally controlled operations in buffer stocks or, preferably, a "commodity reserve" proposal similar in operation to the "commodity currency" plan of Benjamin Graham, but without its monetary-regulatory objectives. He favors long-term contracts between exporting and importing nations, like that embodied in the International Wheat Agreement, but he would prefer such activities to be carried on simultaneously for many commodities under a sort of international board of trade.

The author pays his respects to the "aspirations of agricultural peoples" in underdeveloped areas to raise their incomes; but he sees little hope that the Point Four Program or other measures will achieve this unless new means are found simultaneously to solve the population problems in these areas.

Johnson's newest book evidences an effort at words-of-one-syllable presentation for the lay public. This still does not make it light reading. The analysis is thorough to the point of repetition, with none of the stirring brilliance that characterizes, for example, the final chapter in *Forward Prices.* But even the professional reader will appreciate the relative absence of lapses into complicated jargon, and of those passages that leave us wondering whether we are victims of our own slow-wittedness or merely of a profound nonsequitur on the part of the author.

The book contains a good deal of deserved criticism of policy. Its positive contributions are stimulating, albeit there is no danger of their overhasty adoption. The author neither pleads nor crusades for them, but does a workmanlike job of presenting realistic economic analysis. He reminds his readers of the critical speed of current developments on the international front. But he writes in the tone of one reconciled to the conclusion Schultz has expressed, that "the ideas of economists often have great strength in shaping policy when the time span is one of the decades instead of a single year."

Herman M. Southworth

Social Science Research Methods. *By* WILSON GEE. Appleton-Century-Crofts Inc. New York. 390 pages. c1950.

ALTHOUGH the social sciences have attained a well-defined and expanding place in most college curriculums, relatively few offer comprehensive courses in research methods and procedure. Dr. Gee has been teaching such a course at the University of Virginia and this book has been developed in connection with it. He has undertaken, with a good degree of success, to assemble under one cover the best thinking of a large number of authorities who have attempted to define the scope and meaning of science in general, and of social science in particular. Early chapters are devoted to the definition of social science and the delineation of subject-matter fields. Two chapters are then devoted to the meaning of research and the scientific method. The last half of the book describes the meaning, application, and limitations of the case, statistical, historical, survey, and experimental methods, as they apply to research in the social sciences.

Throughout the book the author depends on many quotations and excerpts. In general, these are well-selected and pertinent quotations which contribute to the subject under discussion and, at the same time, accent the differences in viewpoint of leading authorities. This reviewer can detect no obvious slant or bias in the selection of quotations which would suggest adherence to any particular school of thought. As a book of readings, it would facilitate the reader who wished to learn what the authorities have written on particular points without extensive searching and selection. The quotations are, in general, long enough to present the full meaning of their writers without the risk of superficiality or the danger of distorted meaning which could result from shorter quotations.

Dr. Gee is aware that the most obvious criticism applicable to the book is that of excessive quotation. His justification of this approach is that no one person could speak with authority on so wide a range of intellectual concern as the book attempts to cover. Although this is a defensible position in many respects, some measure of synthesis and perspective could have been obtained by restating in summary fashion at the end of sections and chapters the consensus of the authors quoted. This has been done in places but the instances are all too few. This limitation is no doubt alleviated somewhat when the book is used as a text for a course, and class discussion is used as a means of clarification. But a research worker who is seeking to improve his understanding and technique of a particular study at hand would be less fortunate. But the practicing researcher would gain valuable perspective from the book even though he would still have the problem of deciding upon the application to his particular project of the several research methods described. The chapters on the statistical and survey methods are of most interest to the agricultural economist. But as about equal weight is given to other methods of approaches to social science research, the book is not open to the usual criticism of similar books which place primary emphasis upon a single method.

The last chapter discusses the place of social science research in universities and colleges and in private and public research agencies. Problems of administration and financial limitations are mentioned, as well as the relative merits of individual and group research. Persons engaged in governmental research will probably feel that more attention could well have been given to the contributions made by this type of research, and they would also have welcomed an appraisal by an outsider of its shortcomings and limitations.

William H. Scofield

Forage and Pasture Crops. A Handbook of Information about the Grasses and Legumes Grown for Forage in the United States. By W. A. Wheeler. D. Van Nostrand Company, Inc., New York. 752 pages. 1950.

THE RECENTLY ANNOUNCED grasslands improvement program of the Department of Agriculture and the Association of Land-Grant Colleges and Universities enhances the timeliness of this comprehensive treatment of the development, characteristics, production, and regional adaptability of the grasses and legumes used throughout the United States as forage and soil-conserving crops. Prepared under the auspices of the Field Seed Institute of North America, this book will be a handy reference for those who are interested in improving America's billion acres of grassland.

The author has borrowed not only from his own years of distinguished service in the field of agronomy and seed marketing, but also from that of many of his compatriots in the Department of Agriculture and in the Experiment Stations throughout the country. He has brought together in one authoritative but readable book much of the basic agronomic information on grasses and legumes used for both harvested forage and pasture.

Part I comprises a general discussion of forage and pasture crops, including their characteristics, adaptation, and classification, their response to various soils and fertilizers, their establishment, management, improvement, and protection against insects and diseases, and their use as green manure and cover crops, as hay and as silage. Parts II and III provide a more detailed discussion of each of the commercial legumes and grasses. Part IV includes a table of basic grass-seed data and an extensive list of some 1,200 references which will be especially useful to readers who want more detailed or more localized information. Throughout the book, the amount of pertinent detail is in proportion to the commercial importance of the grass or legume discussed.

This current and comprehensive agronomic reference on grasses and legumes is definitely needed. Its publication serves to emphasize the need for information on the economics of forage production on American farms. The author says that "the ultimate objective of a forage improvement program is to produce superior varieties of each important grass and legume species that will enable farmers to feed their livestock more adequately and more economically." He repeatedly recognizes the need for economic production and utilization of forage crops. But such a handbook cannot provide the farmer with many guides as to the costs and returns to be expected from the various methods of establishing, maintaining, and utilizing the different forage crops.

Farm management specialists and other economists will find a challenge in this agronomic handbook — that of providing comparable economic guides in a comprehensive grassland improvement program. Primarily economic rather than agronomic considerations have tended to retard the improvement of our grasslands. Yet pertinent economic research has lagged far behind agronomic research in this important field. Nor can we confine our research to the experimental phases. If we expect farmers to make the grassland improvements which we think are desirable, we have both a responsibility and an opportunity to help them determine how grasses can be established or improved profitably on their own farms.

H. L. Stewart

First Course in Probability and Statistics. By J. NEYMAN. Henry Holt and Company, New York. 350 pages, illus. 1950.

ANYONE who has some acquaintance with Professor Neyman's contributions to mathematical statistics will naturally expect a scholarly treatment of this subject, combined with a style of writing that makes it come very much to life on the printed pages. He will not be disappointed. Moreover, this book is unique among its fellows in that statistics is presented as a branch of Probability Theory.

According to the preface, it is intended as a text for "(i) students who would like to take just one course in mathematical statistics for purposes of general education, (ii) prospective future mathematical statisticians and (iii) students who specialize or intend to specialize in one of the fields of application and need mathematical statistics as a useful tool in their own studies." He visualizes the first two categories as being freshmen or sophomores, and the third as consisting of senior or graduate students who have more extensive mathematical training and a more mature viewpoint.

It seems to this reviewer that those in the first category would find the book rather heavy going, but if they will expend the necessary effort, they will be rewarded by an insight into the fundamentals of statistical thinking that can hardly be obtained from any other current work on elementary mathematical statistics. But, human nature being as it is, many will probably continue to prefer a more superficial survey of a larger variety of statistical techniques to a searching examination of the foundations upon which those techniques rest.

Professor Neyman's presentation of probability theory, although restricted to the viewpoint of probability "as a mathematical model of relative frequencies observable in a long series of trials," is excellent. He does not hesitate to use the language and notation of the mature mathematical statistician; the beginner need not let this deter him. The vocabulary and symbolism must be learned sometime by a prospective statistician and it may as well be at the start of his career. The exposition is clear and is accompanied by many examples and exercises. Biologists should be delighted to learn that a chapter of 67 pages is devoted to probabilistic problems of genetics, and that other applications to biological statistics appear throughout.

As is to be expected from the title, the book is primarily an exposition of probability theory, with probability defined as a relative frequency, together with applications of that theory to the general problem of testing hypotheses and some typical problems encountered in laboratory experimentation and in sampling. The concepts underlying decision functions play a prominent part and the power of a test is given adequate attention. Considerable material ordinarily given in texts on mathematical statistics is not even mentioned, consequently there is here no threat to the demand for such treatises. Most statistical taxonomists will doubtless classify it as a book on probability rather than on statistics per se. At the same time, it contains much that ought to be included in texts on mathematical statistics but seldom is.

This reviewer recommends the book highly to readers of this journal who have the wish and the fortitude to get at the heart of the subject. It is not easy fare; anyone seeking a pablum, one that will impose no strain on his digestive processes will not find it here. But, for that matter, he will not find it anywhere else either.

Walter A. Hendricks

Land Problems and Policies. Edited by JOHN F. TIMMONS and WILLIAM G. MURRAY. The Iowa State College Press, Ames, Iowa. c1950. 298 pages.

OUTSTANDING STUDENTS of land problems gave this series of lectures before a Land Problems and Policies Seminar at Iowa State College during the summer of 1949. To round out the scope of the book, three lectures are included which were given in the Graduate School of the U. S. Department of Agriculture that year. The objectives of land policy, supply of and demand for land, principles of land use, kinds of land uses including multiple uses, land tenure, the public interest in planning land use, land programs, and the basis for building a land policy are covered.

Readers will not be surprised to find that the viewpoints of the authors are frequently at variance. That stimulates thought. The dismal views of Malthus on population growth in relation to means of subsistence are expressed, with the conclusion that we must "apply science to the control of their numbers." We would certainly prefer to agree with the more optimistic who hold that we have adequate natural resources to provide for an expanding population, and that the problem is primarily one of proper use.

The frank treatment of range land problems is enlightening. The conclusion that "the main problem in western public range land management is landlord-tenant relationships" simplifies matters.

Those who are associated with land programs should give more thought to the statement that a land use program involving public and private interests deals with questions in political economy. Judgments that are made in terms of intangibles cannot be given dollars-and-cents values. This gives rise to the conclusion that "a judgment as to which of the several alternatives will result in the greatest returns" is a public judgment. No one will disagree with the expressed need for planning and for a national land policy.

On the whole the papers are well written and contain thought-provoking material. Most readers, however, will not care to wade through several pages of chapter 8 to learn that "water is essential to all forms of life," or that "practically all municipalities of any size in the United States have a water system." The chapter on the family farm is largely a repetition of materials in previous publications.

The volume provides the latest thinking of leading workers in the field of natural-resource development which is not ordinarily possible in the usual textbook. It provides an excellent reference for land economics students as well as for workers in the field of resource development. The more energetic students will find the references at the end of each chapter of value in obtaining other materials on the same or a related subject. Timmons supplies an objective summarizing final chapter. The editors are justified in feeling that "the information and viewpoints presented in this book will contribute materially to a critical study of land problems and policy."

Buis T. Inman

America's New Frontier, the Mountain West. By MORRIS E. GARNSEY. Alfred A. Knopf, New York. 314 pages. 1950;

The Rural Economy of New England; A Regional Study. By JOHN DONALD BLACK . . . Harvard University Press, Cambridge, Mass. 796 pages. 1950.

ACCORDING to the author, *America's New Frontier* is *The Mountain West,* and in the preface and all through this book he refers to this area as a region. The subtitle of *The Rural Economy of New England* is *"A Regional Study."* While, therefore, a review of either book on some other focus of reference would require discussion considerably different than what is presented here, the authors of these two books have invited a consideration of their contribution to regional analysis. But the books are so dissimilar in content that it would be unreal to review them, so to speak, in parallel columns.

The author of *America's New Frontier, The Mountain West,* believes that this area of eight States has so many common denominators of natural resources and types of production, of history, population characteristics, institutional development, political and other types of ideological behavior, that it acts and is treated by others as a region. Furthermore, that its future depends to a considerable extent on its and others' intelligent recognition of this fact. He says in his preface that "a region is formed to a very large extent around its resources, and the material well-being of its people depends upon the effective utilization of the resources at their disposal." His theory of the value of regionalism is clearly recognized when with the above quotation is coupled the following: "The United States is a single integrated economy within which different regions exist with their own peculiar problems and special interests. But the interests of the parts are also the interests of the whole and the welfare of the National economy depends upon the integration and balance of the various regions which constitute the total National economic organization." He asserts that it is because the economy of The Mountain West is more directly influenced by the physical environment than any other portion of the United States, that it is primarily a livestock and not a crop agricultural economy, is a forest and grazing area, is a mineral and mining area, etc. He relates these basic physically determining facts not only to the economic development of the region but to the attitudes and ideas of its people and to its political behavior. Most important of all he relates them to its potential development and uses a knowledge of them in recommending a 12-point "Program for Action."

The reader should assume from what has been said in this necessarily brief analysis of this book as a contribution to regional analysis that its author used most of its space to present a theory of regionalism. Quite the contrary is true. His 20 chapters and the appendix include 21 tables, 8 maps, and 5 charts, which are unique in their highly selective and analytical presentation and use. Many of them present data on Mountain States and United States comparisons, others on time trends within the region. Moreover, his discussion is replete with economic, social, and political analysis, all of it forthright and intellectually critical.

The author of *The Rural Economy of New England; A Regional Study* does not present any large portion of either his data or ideas in terms of regional concepts. Furthermore, his study deals only with the rural economy of the region and "rural economy is taken in the main to be rural land-use economy." After stating that "the most useful basis of classification of areas for this and other studies like it is similarity of interests and of social relationships," he says ". . . let it be very clear that nothing in the situation gives reason for setting off the States of New England rigidly from all the rest of the country. . . . All that can be said is that the six New England States taken as wholes have more interests and social relationships in common with each other than with any other states, and that it cannot be said of any other that it has more of these in common with the New England States than with some other group of states."

Whether the author would have proved or disproved this assertion had he subjected his myriads of data (and others which would have been required) to statistical tests, he does not know. It is therefore only by broad comparisons of his data, compiled for other than regional analyses, many of them fragmented or atomized so far as a regional universe is concerned, that *regional analyses are accomplished.*

Nevertheless, this volume is a compendium of

knowledge on New England and an exceedingly valuable source book on one of the major regions of the United States. Furthermore, it does not fail in its many detailed analyses to give to any one interested in regional analysis authoritative data on and interpretation of such regional characteristics as types of agricultural production—dairy, poultry, vegetable, maple products, tobacco, and even fruit. It gives due consideration to the unique roles of woodlands, recreational uses of lands, and part-time farming, and relates these to soils, climate, urban population and industrial development.

One looking especially for regional data and interpretations will find them primarily in chapters 1, 2, 35, and 36, where the author sets forth his "assignment," gives his answer to "What is New England?" and discusses "Trends, Prospects, Potentials" and "Regional Policy and Program." In all of these, however, and throughout the book it is clear that the author has little concern with regionalism. Like the author of the other book reviewed here, he is convinced that "any sound program for New England (as a region) must be geared in with National programs in such a way as to promote the common interests of New England and the Nation." Unlike the other author he never says and does not seem to believe that New England is a social entity with its own "peculiar problems and special interests." Undoubtedly there are differences between the two areas and both authors could be right. If so, this in itself is an important regional fact.

Carl C. Taylor

Selected Recent Research Publications in Agricultural Economics Issued by the Bureau of Agricultural Economics and Cooperatively by the State Colleges[1]

CHRISTENSEN, RAYMOND P., and MIGHELL, RONALD L. COMPETITIVE POSITION OF CHICKEN AND EGG PRODUCTION IN THE UNITED STATES. U. S. Dept. Agr. Tech. Bul. 1018, 58 pp., illus.

Attempts to answer questions concerning reasons for the low prices of chickens and eggs and the increase in production, whether the expansion in output will continue, whether producers have a balanced farm program and are using resources to best advantage, whether consumption of protective foods will increase so that present production will be absorbed at prices acceptable to producers.

DAVIS, JOE F., and STRICKLER, PAUL E. ELECTRICITY ON FARMS IN THE EASTERN LIVESTOCK AREA OF IOWA—A PROGRESS REPORT. U. S. Dept. Agr. Cir. 852, 88 pp., illus. September 1950.

Four-fifths of the electricity used on the sample farms in 1947 was used in households. Other uses discussed as well.

DUCOFF, LOUIS J. MIGRATORY FARM WORKERS IN 1949. U. S. Dept. Agr. Agr. Inform. Bul. 25, 20 pp. 1950.

Relates to a sample representing approximately 420,000 persons, 14 years old and over, in civilian population at end of 1949 who did migratory farm work in 1949.

EARLE, WENDELL. BUSINESS OPERATIONS OF NORTHEASTERN WHOLESALE EGG BUYERS. N. Y. (Cornell) Agr. Expt. Sta. Bul. 868, 24 pp. May 1950. (Northeast Regional Publication 4; RMA; BAE cooperating.)

Includes analysis of information obtained in summer of 1948 from 182 wholesale egg receivers: 44 located in New York, 88 in Pennsylvania, 13 in Connecticut, 17 in Maine, and 20 in Massachusetts.

FUGETT, KENNETH A., BAYTON, JAMES A., and BITTING, H. WAYNE. CITRUS PREFERENCES AMONG CUSTOMERS OF SELECTED STORES. Tex. Agr. Expt. Sta. Bul. 722; 48 pp., illus. June 1950 (RMA; BAE cooperating).

At the prevailing level of prices for citrus and competing products consumers were more sensitive to changes in quality of citrus products than to changes in price.

GARLOCK, F. L., TOSTLEBE, A. S., BURROUGHS, R. J., LARSEN, H. C., LINGARD, H. T., JONES, L. A., and WALLACE, M. E. Under the direction of NORMAN J. WALL. THE BALANCE SHEET AND CURRENT FINANCIAL TRENDS OF AGRICULTURE, 1950. U. S. Dept. Agr. Agr. Inform. Bul. 26, 46 pp., illus. October 1950.

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[1] *Processed* reports are indicated as such. All others are *printed*. State publications may be obtained from the issuing agencies of the respective States.

Aggregate assets of agriculture in the United States—both physical and financial, valued at current prices—totaled 127 billion dollars on January 1, 1950, slightly less than a year earlier. This is the first decline since 1940 and probably the first since the middle 1930's.

GARROTT, WILLIAM N. FARM-TO-RETAIL MARGINS FOR MARKETING SOUTHEASTERN EARLY WHITE POTATOES IN PHILADELPHIA, NEW YORK, CHICAGO AND CINCINNATI, 1949. 4 pp. Bur. Agr. Econ. October 1950. (RMA; Ala., Fla., N. C., S. C., Va., and BPISAE cooperating.) [Processed]

Report on margins taken for marketing services on 66 test lots of southeastern potatoes in three major markets.

JENKS, GEORGE F., and HARRISON, ROBERT W. METHODS AND COST OF CLEARING LAND IN NORTHEAST ARKANSAS. Ark. Agr. Expt. Sta. Bul. 495, 43 pp., illus. Fayetteville. June 1950.

Of numerous physical factors that affect the cost of land clearing, density of stand was found to be the most important although drainage and season when cutting is done also affect costs.

KELLY, R. A., WERNER, H. O., KRANTZ, F. A., HEMPHILL, PERRY, and CRAVENS, M. E. RELATIONSHIP OF PRICE AND QUALITY OF POTATOES AT RETAIL LEVEL. Minn. Agr. Expt. Sta. Bul. 406, 28 pp., illus. June 1950. (North Central Regional Publication 16.)

Results of an experiment on size-price relationship as a first step in a cooperative study of the relation of quality to price and volume of sales of potatoes in retail stores.

LILIEHOLM, WILLIAM C. GROVE-TO-RETAIL MARGINS FOR FLORIDA VALENCIA ORANGES MARKETED IN FRESH FORM IN SELECTED CITIES, 1940-48. 22 pp., illus. Bur. Agr. Econ. October 1950 (RMA). [Processed]

During the 1947-48 season, the return to growers of Valencia oranges in Florida was 17 percent of the consumer's dollar spent for oranges in eight major consuming markets.

MORTENSEN, W. P., and GRAF, TRUMAN F. MARKETING EGGS IN THE LAKE STATES. Wis. Agr. Expt. Sta. Research Bul. 168, 32 pp., illus. July 1950. (RMA; BAE cooperating.)

The study upon which this report is based showed that about two-thirds of the consumer's dollar went to the producer and the other one-third to the marketing system.

MULLINS, TROY, and SLUSHER, M. W. COMPARISON OF FARMING SYSTEMS FOR SMALL RICE FARMS IN ARKANSAS. Ark Agr. Expt. Sta. Bul. 498, 42 pp., illus. Fayetteville. June 1950. (RMA; BAE cooperating.)

In Arkansas, a high specialization is associated with production of rice, although to maintain yields, it must be rotated with other crops or land uses.

RAUCHENSTEIN, EMIL, WILCOX, WALTER W., and SMITH, EDWARD J. CHANGES IN DAIRY FARMING IN WISCONSIN, 1930-1948. Wis. Agr. Expt. Sta. Reseach Bul. 166, 40 pp., illus. February 1950.

Allowing interest at current rates on the investment, the average family-operated dairy farm had no return per hour of labor in 1931 and 1932, and around $0.60 to $0.70 return per hour in 1947 and 1948.

REEVES, GEORGE T., and SMITH, HELEN V. PATTERN OF DISTRIBUTION OF FRUITS AND VEGETABLES SHIPPED BY RAILROAD, 1939 AND 1947, AND TRANSPORTATION CHARGES, 1947. 55 pp. Bur. Agr. Econ. October 1950. (RMA) [Processed]

Summarizes the major traffic flows, transportation charges, and short-line distances from leading States of origin to major States of destination.

SABINE, A. R. MARKETING CHANNELS AND MARGINS FOR SOYBEANS AND SOYBEAN PRODUCTS IN ILLINOIS, CROP YEARS 1947 AND 1948. Bur. Agr. Econ. 24 pp., illus. October 1950. (RMA) [Processed]

About 96 percent of the soybeans sold off Illinois farms were sold to country elevators. The gross margin received by these elevators was 13.6 cents per bushel for the 1947 crop and 8.0 cents for 1948.

SOLBERG, ERLING D. LEGAL ASPECTS OF FARM TENANCY IN TEXAS. Tex. Agr. Expt. Sta. Bul 718, 255 pp. February 1950. (BAE cooperating)

Among topics discussed are laws relating to the creation of various types of tenancy and share-cropping agreements and the rights and duties of landlords, tenants, and croppers thereunder.

STIPPLER, H. H. and LAW, A. G. PRODUCTION AND HARVESTING OF HAY IN WASHINGTON CENTRAL IRRIGATED AREA, 1945. Wash. Agr. Expt. Sta. Bul. 512, 40 pp. November 1949. BAE cooperating)

Stresses the fact that timeliness and speed of operation in harvesting are important in production of high-quality hay.

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. ABILITY TO DISCRIMINATE AND PREFERENCES IN REGARD TO CANNED ORANGE JUICE THAT VARY IN BRIX-ACID RATIO. 27 pp. Washington, D. C. November 1950. (RMA; Fla. Citrus Com. and Fla. Citrus Expt. Sta. cooperating.) [Processed]

Reports exploratory research indicating that juice with a Brix-acid ratio of 13.7 is preferred more often than the 8.2 juice.

UNITED STATES BUREAU OF AGRICULTURAL ECONOMICS. RICE PREFERENCES AMONG HOUSEHOLD CONSUMERS. U. S. Dept. Agr. Agr. Inform. Bul. 15, 101 pp., illus. July 1950 (RMA).

Consumer preferences for rice are analyzed with the thought that ways may be found to expand domestic demand among those who are either nonusers or small users.

WESTERN LIVESTOCK MARKETING RESEARCH TECHNICAL COMMITTEE. SHIFTS IN THE TRADE IN WESTERN SLAUGHTER LIVESTOCK. U. S. Dept. Agr. Agr. Inform. Bul. 14, 67 pp., illus. 1950. (RMA)

Discloses a growing western demand for meat, which, in effect, means a growing western demand for western-grown slaughter livestock.

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